Power Up - ABSTRACT

Have you ever considered that there are multiple sources of kinetic energy that have not been tapped into? A readily available source of kinetic energy is from revolving objects, rotated mechanically or by humans in high traffic areas. We sought to create a product that could be attached to revolving doors to harness the kinetic energy generated from the repeated action of the door. The idea behind the product was to use a revolving door to spin a motor which would send current to a supercapacitor that would in turn power LED lights. A series of gears would enhance the impact of each rotation of the door, to increase the RPM applied to the final gear on the motor shaft. We tried four different prototypes with design modifications at each level. Unfortunately, we were unable to assemble our last prototype as a fully functioning one due to our lack of access to tools or a machine shop where far more precise measurements and cuts could be made. However, our calculations showed that with our gear ratio combination the output from the motor should be just under 1 volt per minute. At that rate, it would take seven minutes to fully charge a supercapacitor which would power an LED light for 25 minutes. We believe that this would be a large step in the right direction of harnessing human energy and has potential for a multitude of applications.

Mission Folder: View Mission for 'Power Up'

State
Oklahoma
Grade
9th
Mission Challenge
Alternative Sources of Energy
Method
Engineering Design Process
Students

Rmackey
rkaul8280
lhilst

Team Collaboration

Uploaded Files:

- [**View**] **Attachment A** (By: rkaul8280, 03/02/2015, .docx)

Definitions of Key Words and Terminology

(1) Describe the plan your team used to complete your Mission Folder. Be sure to explain the role of each team member and how you shared and assigned responsibilities. Describe your team's process to ensure that assignments were completed on time and deadlines were met.
Team Power Up - in search of alternative sources of energy. This was our mission.
The plan used to complete the mission folder was to initially generate a list of topics that we were interested in. We then researched each topic and narrowed down the options by a vote. Since we were all interested in alternative sources of energy we chose to focus on producing a product that would harness kinetic and convert it to electricity.

Team member 1: Researched piezoelectricity, and the many ways it could be applied in society. Coordinated construction of the gear system.
Team member 2: Researched kinetic energy and different ways kinetic energy is produced and harnessed. Used Inventor to diagram models.
Team member 3: Coordinated meetings with engineers and others experts. Managed all emails and paper work via Google Drive.

We are a group of three girls who are great friends and share similar interests such as Band, Chinese, and Girl Scouts and work well as a team.
To ensure our team was on track, we assigned a research topic weekly that needed to be completed by the next meeting. We had team meetings every Wednesday after school. About every other week we would either meet with or talk on the phone with people who had expertise in this area. We did all the testing as a team. For this mission each of us became familiar with a list of terms (See Attachment A) Each of us was responsible for writing a part of the mission folder and then we approved all the writing of the mission folder collaboratively.

Engineering Design

Uploaded Files:

- [**View**] **Attachment B** (By: lhilst, 03/01/2015, .JPG)

    Diagram of Circuit for Revolving Door Prototype
- [**View**] **Attachment C** (By: rkaul8280, 03/01/2015, .JPG)

    Prototype 1: Motor to battery
- [**View**] **Attachment D** (By: rkaul8280, 03/02/2015, .JPG)

    Prototype 2: Drill to Motor to Capacitor
- [**View**] **Attachment D1** (By: rkaul8280, 03/02/2015, .JPG)

    Prototype 2A- Capacitor to Breadboard and LED light
- [**View**] **Attachment E** (By: rkaul8280, 03/02/2015, .JPG)

    Prototype 3: Worm Gear Box to Capacitor
- [**View**] **Attachment E1** (By: rkaul8280, 03/02/2015, .JPG)

    Prototype 3A: Close up of the Worm Gearbox
- [**View**] **Attachment F** (By: rkaul8280, 03/02/2015, .JPG)

    Prototype 4: Gearbox assembly to motor to Capacitor
- [**View**] **Attachment F1** (By: rkaul8280, 03/02/2015, .JPG)

    Working on creating gearbox
- [**View**] **Attachment F2** (By: rkaul8280, 03/02/2015, .jpg)

    Prototype 4B: Gearbox holes and cutting gearbox
- [**View**] **Attachment F3** (By: rkaul8280, 03/02/2015, .jpg)

    Prototype 4C: Trying gear combinations.
- [**View**] **Attachment G** (By: rkaul8280, 03/02/2015, .docx)

    Gear ratio Calculations for prototype 4

Problem Statement

(1) What problem in your community did your team try to solve? Why is this problem important to your community?

Society today is faced with a “power” struggle like no other in history. According to the Institute of Mechanical Engineers, there is only enough oil left to last 40 years at the current production rate. We need to find sources of renewable energies such as solar and wind before non-renewable resources run out. Our team is approaching the field of alternative energy sources with the idea of using the kinetic energy created by the opening and closing of doors to power other things such as the handicapped door, lights, etc. We would like to accomplish this by harnessing the energy created by the repeated motion of opening and closing doors. In public places such as schools, airports and office buildings, this action occurs frequently. The kinetic energy being created could be used to power another source. The technique of using human produced energy such as when a door opens to power things is called crowd harvesting. This is an area that has barely been explored by scientists today and has the potential to be a prominent source of renewable energy.

(2) List at least 10 resources you used to complete your research (e.g., websites, professional journals, periodicals, subject matter experts).

SUBJECT MATTER EXPERTS CONSULTED:

Kaveh Ashenayi, Ph. D. - Chair of the Faculty of Electrical and Computer Engineering
Norberg Department Chair in Electrical Engineering and Professor of Electrical Engineering. College of Engineering &

Natural Sciences. Tulsa University

MIke Carney - Curriculum Resource Instructor, Jenks High School

Douglas Jussaume- Applied Associate Professor of Electrical Engineering
College of Engineering & Natural Sciences. Tulsa University

Teddy Wyatt- Tulsa Technology Center, Pre-engineering instructor.

Mr. Grant Hollingsworth. Design Engineer L-3 Communications

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"Harnessing Human Power for Alternative Energy in Fitness Facilities: A Case Study | Association for the

Advancement of Sustainability in Higher Education (AASHE)." Harnessing Human Power for Alternative Energy in Fitness Facilities: A Case Study | Association for the Advancement of Sustainability in Higher Education (AASHE). Web. 2 Mar. 2015. http://www.aashe.org/resources/student-research/harnessing-human-power-alternative-energy-fitness-facilities-case-study.

"Scientists Harness Human Power for Electricity." Scientific American Global RSS. Web. 2 Mar. 2015. http://www.scientificamerican.com/article/scientists-harness-human-power-electricity/.

(3) Describe what you learned in your research.

The U.S. Energy Information Administration reports that the U.S. uses 6.89 billion barrels of oil a year (http://www.eia.gov/). According to the Institute of Mechanical Engineers there is only enough oil left to last us 40 years (http://www.imeche.org/). Oil is societies' source of power and it is running out fast. Since current forms of energy are running out, we need to find alternatives for the future. Recent research into renewable energies shows that we can harness power from the sun, wind and even our own bodies. The idea of using our bodies to power machines has been around since the 19th century with the use of pedal powered machines (http://www.lowtechmagazine.com/human-powered-machines/). With research advances in harnessing human energy, many discoveries and potential applications have been explored.

One such application is piezoelectricity. The term piezoelectricity comes from the greek words piezen, to squeeze or press, and piezo, push, (http://www.nanomotion.com/piezo-ceramic-motor-technology/piezoelectric-effect/). The piezoelectric effect is when certain materials produce an electric charge when put under pressure. These materials have been used today to harness the energy generated from footsteps in high traffic areas. These products were even used in the London 2012 Olympics by Pavegen, a largely successful producer of piezoelectric products. Another successful use of human generated energy is a knee brace that is being used to power cell phones as a person moves (http://gizmodo.com/354097/knee-brace-charges-your-cellphone). The idea for this product was for soldiers or hikers to power a GPS. Another way science has started to harness energy is through harnessing sound energy through products such as the clapper. According to Oil Price, energy is never destroyed, but it is converted into other forms of energy (http://oilprice.com/Latest-Energy-News/World-News/Gyms-to-convert-Human-Energy-into-Electricity-for-the-Grid.html).

Using kinetic energy, energy that a body possesses by virtue of being in motion, has also been a recent trend in the scientific community. Kinetic energy comes from things moving such as walking, hinges, rotating gears, and even typing. Any and all types of movement produce kinetic energy. The most recent and innovative application of this has been the creation of green gyms. Green gyms focus on converting kinetic energy generated by the human body into electricity. When humans lift weights, exercise and use the treadmill, they are expending energy. This energy is then harnessed and converted into electricity. Users of this equipment have an opportunity to be paid for the energy they expend and or lower the amount of money they pay for their electricity bill. The most exciting part about this technology is that it is renewable. We will never run out of kinetic energy that is created by human movement and actions. Green Gyms and exercise equipment that harnesses human energy are being used all over the country. (http://www.texastribune.org/2010/07/09/texas-universities-harness-human-power/) Texas University has been a model for adopting these green changes. With the use of green gyms they have estimated that a 30 minute workout will produce about 50 watt hours which could power a laptop for about an hour. It would take more than an 18 hour work-out to run a hair dryer for an hour. (http://oilprice.com/Latest-Energy-News/World-News/Gyms-to-Convert-Human-Energy-into-Electricity-for-the-Grid.html) . Not only is converting this energy green and good for the environment it also provides people with an idea of how they can make a direct impact on renewable energy sources.

In this research project our goal is to harness human energy in an innovative way. Research shows that smart gyms use the energy created by people biking or exercising to power the gym. According to The Human Powered Gym by Kevin Foley, there have been gyms set up such as the Green Microgym and Go Green Fitness that are human powered gyms (http://www.ihrsa.org/home/2010/10/1/the-human-powered-gym.html). Pedaling on a regular bicycle has been used for the same purpose of generating energy (http://www.popularmechanics.com/technology/how-to/gadgets/pedal-power-how-to-build-a-bike-generator-16627209). The mechanism by which this occurs is as follows.

The back wheel of the bike is connected to a motor or generator. This motor then feeds into a battery such that the energy can only flow one way. The battery is then connected to the inverter to convert the DC current to an AC current. This in turn can be used to power the gym, a light bulb, electronic devices, etc. The kinetic energy from exercising feeds into the motor and is converted to electricity. We are taking the mechanics of this and applying them in a situation in which large numbers of people repeat the same action. For example, revolving doors in settings like a school, an office building or an airport. We want to take the idea of using kinetic energy from the repeated motion of a revolving door and possibly converting it to electrical energy.

Experimental Design

(4) Develop a design statement. Be sure to describe what exactly your device should be able to do. Do not describe HOW it's going to do what it needs to do.

The device being created in this project will be designed to harness the kinetic energy created by humans using a revolving door. This energy would then be converted to electricity and be used to power LED lights or other devices. See Attachment B for prototype model

(5) Determine the criteria for a successful solution and identify constraints for your design. Discuss what the device must have in order to accomplish its job and the restrictions of the device (i.e. the size, the cost, the weight, etc.).

A successful solution to this problem would allow us to use the kinetic energy from the repeated motion of a revolving door to power (spin or rotate) a motor which would then be used to charge a capacitor or battery like device. Based on the amount of charge created, this could be used to power an LED light or other devices.

The constraint of our design would be that the speed of the revolving door is slow and therefore, might not create enough rotations per minute to power the motor adequately. This in turn creates the constraint of having insufficient voltage to power the capacitor or battery fast enough. In order to address this issue, our device would need a gear system attached to the revolving door and motor to enhance the number of rotations per minute. This should allow us to get the voltage needed to power the capacitor or battery.

In our current design we are testing a small scale model of this idea to test feasibility. At this time we are seeking proof of concept to assess if this is even possible. Other restrictions for a full scale model is attachment to the door system. Clearly the size would need to be larger but it would need to be something that is easy enough to mount on a door without effecting the smooth movement. Another restriction would be cost. The cost of installing the mechanism should not be too expensive, but it will pay off by creating electricity through the use of harnessing human energy and it preserves other sources of non renewable energy.

(6) Identify the relevant variables you will use to test your prototype or model and explain how you will measure your variables.

RPM (Rotations per minute): We would need to assess the rotations per minute for the revolving door, followed by the RPM required to power the motor.

Gear Ratios: Gears would need to be used to increase the RPM enough to power the motor so that we can optimally charge a supercapacitor or battery. Gear ratios would need to be calculated and appropriate gears used to achieve this.

Voltage: Adequate voltage would need to be generated to charge the supercapacitor or battery. The output of voltage being created from the motor would be measured by a multimeter. We are measuring the amount of time it takes the motor to produce enough voltage to power the supercapacitor.

Time: The amount of time taken to fully charge the supercapacitor would need to be measured.

Output: The length of time that the supercapacitor could illuminate the LED light would be our dependent variable.

Build Prototype or Model

(7) Develop a design and list the materials you used in your design. Include technologies you used (e.g., scientific equipment, internet resources, computer programs, multimedia, etc.).

A revolving mechanism will mimic the action of a door. This will be attached to a motor by gears to spin the motor at fast speed. The motor will act as a generator. The motor will be attached to a supercapacitor or battery with alligator clips and wires. To make sure that the energy flows one way into the supercapacitor or battery, a diode will be used. Once the supercapacitor is charged, it will be used to power an LED light using a breadboard and resistor.

List of Materials and technology used
Motor- Integy 12 volt 55x1 RPM
Supercapacitor 5.5 Volt Kanthal
Alligator Clips- to connect the motor to the supercapacitor or battery and supercapacitor
Multimeter
Breadboard
LED Light
4 speed worm gearbox
Drill
Resistor
Diode
Gears 48 pitch: 35,14,12 pinion
Internet resources for background research
Computer program- Inventor- used to construct model
Google Drive, Word, Gmail- to facilitate sharing of documents

(8) Explain how you built your prototype(s) or model(s)? Include each of the steps in your process.

Our first prototype was designed to be like the models used to generate power using a bike. Like the bike model, a rotating mechanism (a drill - in our model) was used to spin the gear on the motor shaft with which we then tried to charge the battery. Once the battery was charged, it would be used to light something. To do this we used a 12 volt motor and a 12 volt battery. The problem we ran into was that the motor was not spinning fast enough to create adequate voltage to power the battery. See Attachment C

As this first prototype did not work in the way we had hoped, we consulted other professionals and did further research. Consensus was to charge a supercapacitor instead of a battery.

The reasons being -

i) A supercapacitor needs less voltage than a battery.
ii) A supercapacitor is also able to charge faster than a battery.
iii) A supercapacitor has an unlimited life cycle, meaning it can be recharged indefinitely with no battery life issues.
iv) A supercapacitor is able to discharge energy gradually unlike capacitors
(http://my.teslamotors.com/fr_CH/forum/forums/use-battery-pack-opposed-super-capacitor-pack).
http://batteryuniversity.com/learn/article/whats_the_role_of_the_supercapacitor

In the second prototype that we tested, we used the same model as in prototype 1. The second model we tested was the exact same setup but instead of a battery, a supercapacitor was used. The drill was used to turn the motor and the motor was also connected to the supercapacitor with the use of a diode. Once the supercapacitor was charged, then it could be connected to the breadboard and the LED. We were still not generating voltage fast enough to charge the supercapacitor in a reasonable amount of time. The only way to get enough voltage was to use gears to enhance the RPM. These gears would be attached to the rotating mechanism which would then be attached to the shaft of the motor. See Attachment D, D1

In the third prototype, we tried to work with a gearbox used in Radio Control vehicles. The intent was to use a rotational mechanism to spin the gears which in turn would spin the gear attached to the motor shaft. The gearbox we bought had a motor linked to the gears with a Worm gear. The motor was successfully spinning the gears when it was powered by electricity. However, when we tried to reverse the process, the gearbox would not allow for the gears to spin the motor. We attempted to use the gearbox with other motors but were unsuccessful. See Attachment E, E1

In prototype four, we attempted to build our own gearbox to fit onto the gear attached to the motor shaft so that it could power the motor. We planned on using the gear ratio 35:12 three times, 35:14 one time and the ratio 14:12 one time as it is connected to the motor. All of our gears were 48 pitch gears and would be mounted on 3 shafts in a step like manner. We had four 35 tooth gears, four 12 tooth gears, and one 14 tooth gear. Once the gearbox is assembled, it would then be attached to the motor. The motor would be connected to the supercapacitor which once charged, would be attached to a resistor and an LED using wires and a breadboard. The gear ratio calculations shown in Attachment G reflected that with this gear ratio using a 6V , 5800 RPM motor 1 volt would be generated in about 1 minute. Our estimate was that we would be able to charge the capacitor in about 7 minutes. See Attachment F, F1 F2 F3

<u>Test Prototype</u>

(9) Describe the data you collected and observed in your prototype testing (use of data tables, charts, and/or graphs are encouraged).

Prototype 1: 12V Motor to 12V Battery

Using the drill to rotate the gear on the motor shaft at minimum 400 RPM led to an output of .1 volt in a minute. There was no detectable charge on the battery as the flow of current was very slow.

The multimeter applied to the motor directly measured this charge.

Prototype 2: 12V Motor to 5.5 V Kanthal 1.0F supercapacitor

Using the drill to rotate the gear on the motor shaft at minimum 400 RPM led to an output of .1 volt in a minute.

The multimeter applied to the supercapacitor directly measured this charge.

We were unable to fully charge the supercapacitor in this manner.

We did measure that the fully charged supercapacitor could light the LED light on a breadboard for 25 minutes.

Prototype 3: Use of a Worm Gearbox

The gear ratios and assembly of this gearbox was designed to generate 1428.2:1 which magnified the rotational impact significantly.

This gearbox allowed 7 RPM - This could have potentially allow for final rotational impact to be up to 9,997.4 RPM to the gear mounted to the motor shaft.

Unfortunately, the Worm gearbox construction did not allow for us to use the gears to power the motor. It was specifically designed to have the charged motor move the gears.

Prototype 4:Gearbox Assembly (See Attachment G)

Gear ratio calculations in the attached table show that the combination of gears that were to be used in the final gearbox 3- 35:12 gear sets, 1- 35:14 gear set and 1 final 14:12 gear set connected to the motor shaft should generate an output of 1 volt in a little over a minute, if a revolving door was moving at 12 RPM. The motor for the computation was a 6V, 5800 rpm motor.

Unfortunately we were unable to assemble and test this gearbox in the manner planned due to not having appropriate equipment to assemble it with adequate precision.

(10) Analyze the data you collected and observed in your prototype testing. Does your data support or refute your design statement? Do not answer with yes or no. Explain your answer using 'Our data supports/refutes the design statement because...'

In our first prototype, the data we collected supported our design statement partially. We were able to send charge to the battery by spinning the shaft of our motor but it was less than 0.1 volt in a minute of using the drill. At that rate the battery showed no detectable charge but the multimeter attached to the motor showed that was the output. Clearly this was very impractical. The battery would have taken too long to charge and would have lost its charge before it could be used.

In our second prototype where we used a supercapacitor instead of a battery, we only found partial support for our design statement. This time we were able to charge our supercapacitor at a rate of 0.1 volt per minute. The supercapacitor showed a steady increase in charge but this was still an impractical prototype, due to the length of time it would take to completely charge.

In our third prototype using a 4-speed Worm gearbox, we were not able to support our design statement because we could not use the gearbox to power the motor. The Worm gear would not allow the gearbox to work backwards. Therefore, this prototype was not useful in supporting our design statement. However, the gear ratios would have been 1428.2:1 which magnified the rotational impact significantly.

In the fourth prototype we attempted to create our own gearbox. We were unable to get data to support our design statement because we were unable to assemble the gearbox in a manner that could function as a complete unit. The issues with this gearbox were caused by technical difficulties addressed in sources of error section below. However, the mathematical calculations that we were able to do did support that this version of our prototype would be able to charge our supercapacitor within about 7 minutes at the rate of 12 manual rotations a minute. A fully charged supercapacitor would light a LED for about 25 minutes.

(11) Explain any sources of error and how these could have affected your results

During this project we found different sources of error which led to the development of each new prototype. The sequence of our four prototypes were each designed to fix errors found in the previous one.

In our first prototype, we used a drill to spin the shaft of our motor. Using the drill, we simply could not produce enough RPM to generate the voltage we needed to charge our twelve volt battery. Research showed that supercapacitors would be a better option than a battery.

In the second prototype, instead of a battery we used a supercapacitor and attached it to a breadboard and an LED. Using a drill, we were able to charge a supercapacitor but it took an impractical amount of time.

Consultation with an engineer indicated that we would need to reach at least 5,000 RPM to charge a supercapacitor in a reasonable amount of time. Since a revolving door does not rotate at that high of a speed, gears would allow us to magnify the impact of each revolution of the revolving mechanism.

We utilized a 4-Speed Worm Gearbox in our third prototype. Our final gear in our gearbox was designed to reach 9,997.4 RPM. This gearbox was designed for use in Radio Control cars. When the motor in the gearbox is connected to power, the motor uses a worm gear to power the gears. In this prototype we tried to reverse this process. With every manual rotation of the first gear, we wanted to have the gears power the motor. Unfortunately, the gearbox was built so that this could not happen. The error in this design was that the Worm gear locked the motor into the gears so that we could not reverse the direction of the gears.

In the fourth prototype we bought and attempted to assemble individual gears using gear ratio calculations to magnify each rotation effect to 873.89 RPM. The assembly of this gearbox required precise measurements, drilling holes to perfectly align the gear shafts and gears in metal, setting the gears to fit perfectly against the motor, supporting and stabilizing the motor, Despite our best efforts, we were not able to develop a perfectly aligned gearbox. We recognize that such a complex assembly required technical experts and tools to which we did not have access. However, the mathematical computations do support that we could have generated enough RPM and voltage to fully charge a supercapacitor in about 7 minutes of rotation. This would have powered the LED for about 25 minutes.

<u>Drawing Conclusions</u>

(12) Interpret and evaluate your results and write a conclusion statement that includes the following: Describe what you would do if you wanted to retest or further test your design. Evaluate the usefulness of your prototype or model. What changes would you make to your prototype or model for the future, if any?

Overall our findings showed that while a fully functioning prototype was not achieved, in time it might be. Our calculations showed that with the gear sets we had, this product could become a reality with time and the right tools. When trying to find the most effective use of our gears we used many different combinations. After trying multiple combinations of gears we finalized a system using three pairs of 35 to 12 toothed gears, one 35 to 14 toothed gear pair and one 14 to 12 toothed gear pair. We believed this to be the most effective pairing system because with this combination we achieved the most RPM from the initial 12 RPM we would expect from a typical revolving door (International Revolving Door Company). Our next steps in further testing of our prototypes would include assembling a gearbox in a machine shop using the appropriate tools so that the measurements are more exact than what we can do with the tools we had access to. We would assess how much time it takes to charge a supercapacitor and how long it can power other devices such as LED lights. If this works, we would then test this on a full scale application as applied to an operational revolving door system. We tested for proof of concept initially. A significant flaw in design would be that the prototype was not being built with a scale. We would have liked to build it to a quarter scale, but time and tool availability did not allow for this. When retesting, we would like to test different combinations of gears and motor types. Along with this, we would like to run the power to an end receptacle other than an LED and change the current from AC to DC for powering lights in buildings that do not use LED lights. Converting the current from AC to DC is also something we would like to include in future applications. Other applications of this product could include a hinged door, moving walkways, turnstiles and playgrounds. By attaching this product to other objects that rotate, we hope to harness a portion of the kinetic energy humans generate on a daily basis. "As it is often said an equation is not merely a recipe for algebraic problem solving, but also a guide to thinking about the relationship between quantities" (www.thephysicsclassroom.com). With this project everything relies on the balanced relationships between quantities. We believe that if this balance is achieved this product will work.

Community Benefit

(1) How could your design help solve your problem and benefit your community? Describe next steps for further research/design and how you have or how you could implement your solution in the future.
The world only has a limited amount of nonrenewable energy resources. It is important that we preserve these resources before they run out. This project focuses on using kinetic energy to power lights instead of using non-renewable energy resources. Scientists have already worked on finding solutions to this problem. For example, there are several smart gyms which use kinetic energy from people working out to power the gym. Science is exploring applications for crowd harvesting, where multiple people are repeating an action and creating kinetic energy. Have you ever thought about how much kinetic energy is created by people walking through revolving doors, especially in places which are very crowded such as schools, airports, or even offices? Hundreds of thousands of people walk through the revolving doors of airports and turnstiles at railway stations every single day. If we could find an innovative way to harness this untapped energy source, then this would provide a unique source of renewable energy. If the mechanics of the gear system to convert the kinetic energy from opening and closing the door to electricity are effective, then it can be applied in multiple settings. This idea can be applied anywhere that something rotates at a repeated frequent rate. Examples are swings and merry-go-rounds on playgrounds, escalators, walkways, and doors on trains. The possibilities are endless.

Our steps for further improvements for this design include developing a gear system that provides enough speed and torque to power the motor and generate adequate voltage for the supercapacitor. This would need to be small enough to mount comfortably on a revolving door without causing problems with its function. We realize that this gear system would need to be assembled with the use of computer aided design and professional assembly. Following this it would need to be tested on a revolving door. Based on the results, necessary adjustments would need to be made before testing it in other settings.

Our project has the potential to not just impact one city or one state, it can benefit the whole country and the world. Preserving our environment and conserving our resources is extremely important for the long term benefit of the Earth.

Mission Verification

(1) Does your Mission Folder project involve vertebrate testing, defined as animals with backbones and spinal columns (which includes humans)? If yes, team must complete and attach an IRB.

No

(2) Did your team use a survey for any part of your project? If yes, team must complete and attach a survey approval form.

No

(3) You will need to include an abstract of 250 words or less. As part of the abstract you will need to describe your project and explain how you used STEM (Science, Technology, Engineering and Mathematics) to improve your community

Have you ever considered that there are multiple sources of kinetic energy that have not been tapped into? A readily available source of kinetic energy is from revolving objects, rotated mechanically or by humans in high traffic areas. We sought to create a product that could be attached to revolving doors to harness the kinetic energy generated from the repeated action of the door. The idea behind the product was to use a revolving door to spin a motor which would send current to a supercapacitor that would in turn power LED lights. A series of gears would enhance the impact of each rotation of the door, to increase the RPM applied to the final gear on the motor shaft. We tried four different prototypes with design modifications at each level. Unfortunately, we were unable to assemble our last prototype as a fully functioning one due to our lack of access to tools or a machine shop where far more precise measurements and cuts could be made. However, our calculations showed that with our gear ratio combination the output from the motor should be just under 1 volt per minute. At that rate, it would take seven minutes to fully charge a supercapacitor which would power an LED light for 25 minutes. We believe that this would be a large step in the right direction of harnessing human energy and has potential for a multitude of applications.

Definitions of Key Words and Terminology Used in Power Up Revolving Door Research

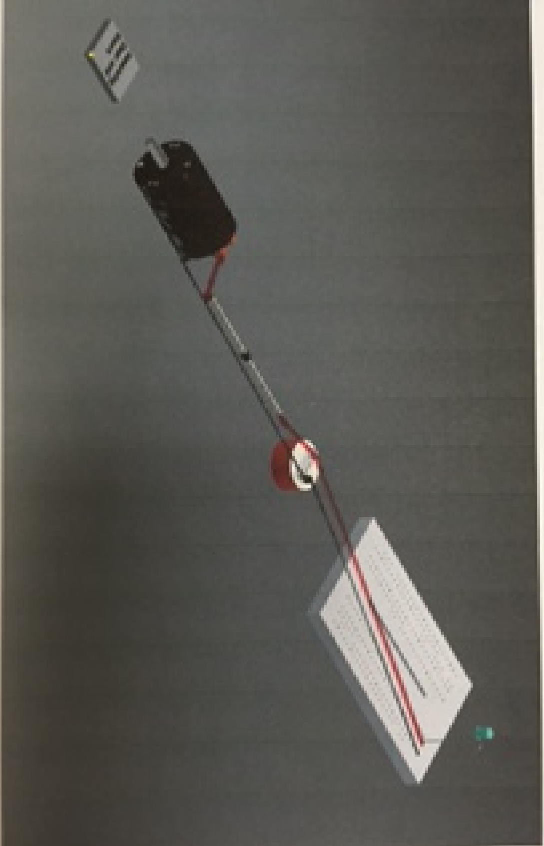
Definitions of Engineering Terms

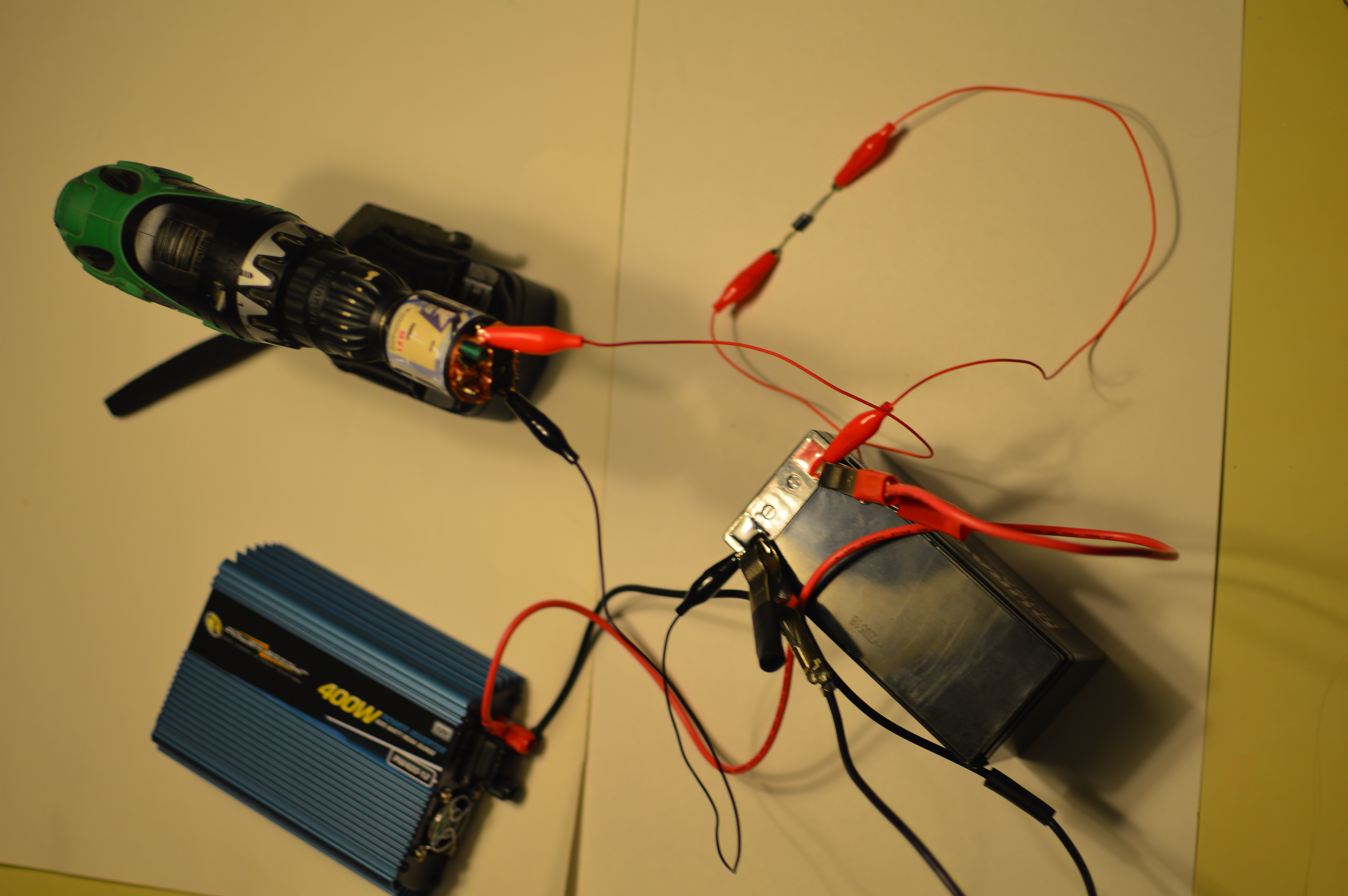
Amperage- the strength of an electric current in amperes.
Current-a flow of electric charge. In electric circuits this charge is often carried by moving electrons in a wire. It can also be carried by ions in an electrolyte, or by both ions and electrons such as in a plasma.
Energy- Energy exists in many different forms. Examples of these are: light energy, heat energy, mechanical energy, gravitational energy, electrical energy, sound energy, chemical energy, nuclear or atomic energy and so on. These forms of energy can be transferred and transformed between one another.Although there are many specific types of energy, the two major forms are Kinetic Energy and Potential Energy. Kinetic energy is the energy in moving objects or mass. Wind energy is an example. The molecules of gas within the air, are moving giving them kinetic energy.
Gear ratios- the ratio between the rates at which the last and first gears rotate. This is useful when using mathematical calculations to find RPM.
Kinetic Energy-energy that a body possesses by virtue of being in motion.
RPM-(Revolutions Per Minute) With electric and electronics devices, RPM measures the rotational speed of the motor's spindle.
Voltage-an electromotive force or potential difference expressed in volts.
Watt-the SI unit of power, equivalent to one joule per second, corresponding to the power in an electric circuit in which the potential difference is one volt and the current one ampere.
Wattage-a measure of electrical power expressed in watts.

Definitions of Materials Used

Alligator Clips on Wires-A spring-loaded clip with serrated jaws, often used to make temporary electrical connections.
Battery-a container consisting of one or more cells, in which chemical energy is converted into electricity and used as a source of power.
Bread board-a board for making an experimental model of an electric circuit.
Diode-a semiconductor device with two terminals, typically allowing the flow of current in one direction only. A thermionic tube having two electrodes (an anode and a cathode).
Inverter-an apparatus that converts direct current into alternating current.
LED-a semiconductor device that emits visible light when an electric current passes through it. The light is not particularly bright, but in most LEDs it is monochromatic, occurring at a single wavelength.
Motor-a machine, especially one powered by electricity or internal combustion, that supplies motive power for a vehicle or for some other device with moving parts.
Multimeter-an instrument designed to measure electric current, voltage, and usually resistance, typically over several ranges of value.
Resistor-a device having a designed resistance to the passage of an electric current.
Super Capacitor-sometimes ultracapacitor, formerly electric double-layer capacitor (EDLC)) is a high-capacity electrochemical capacitor with capacitance values up to 10,000 farads at 1.2 volt that bridge the gap between electrolytic capacitors and rechargeable batteries.
Wires-metal drawn out into the form of a thin flexible thread or rod.

Worm Gear Box-The two elements are also called the worm screw and worm wheel. Like other gear arrangements, a worm drive can reduce rotational speed or allow higher torque to be transmitted.

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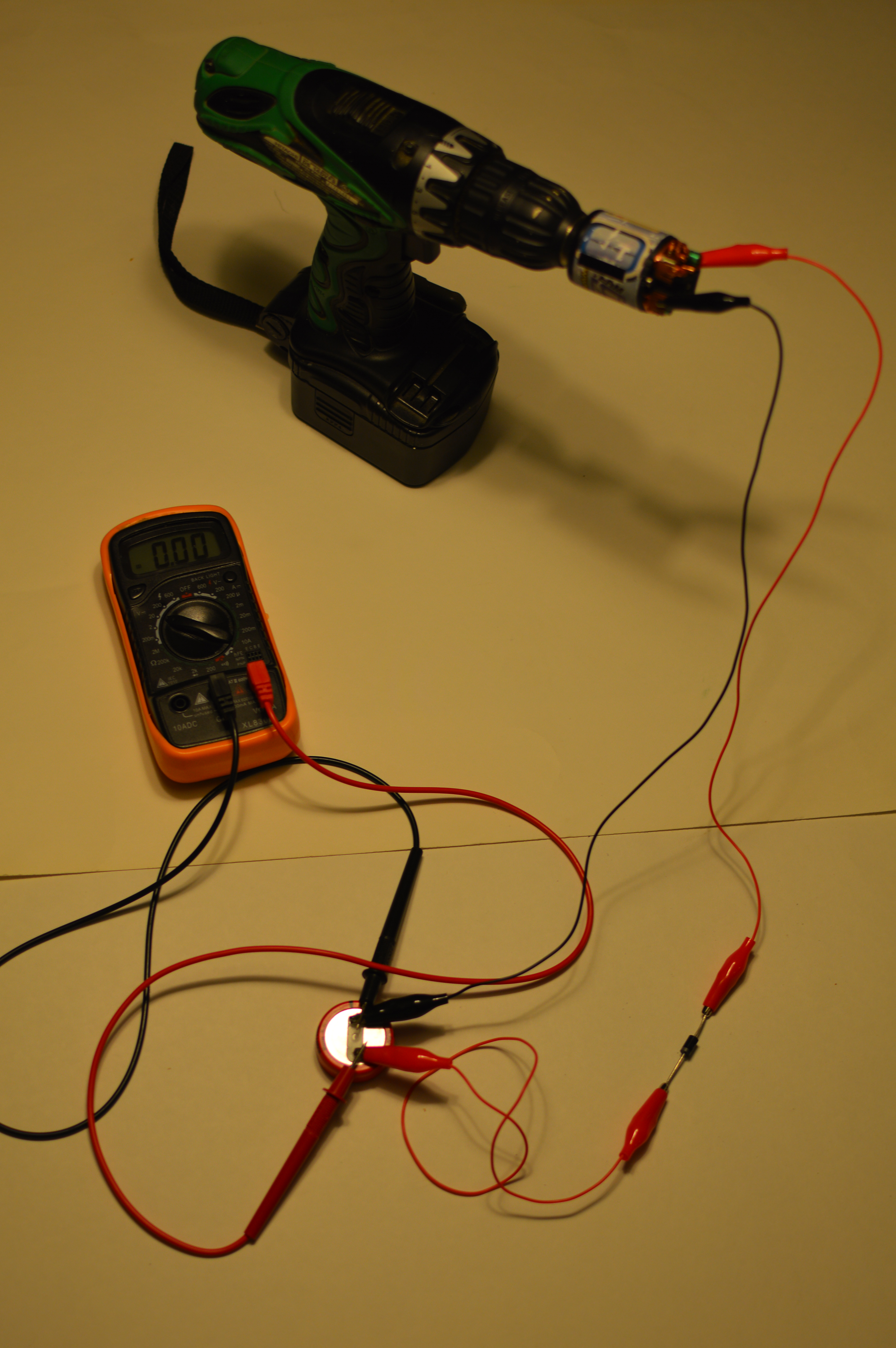
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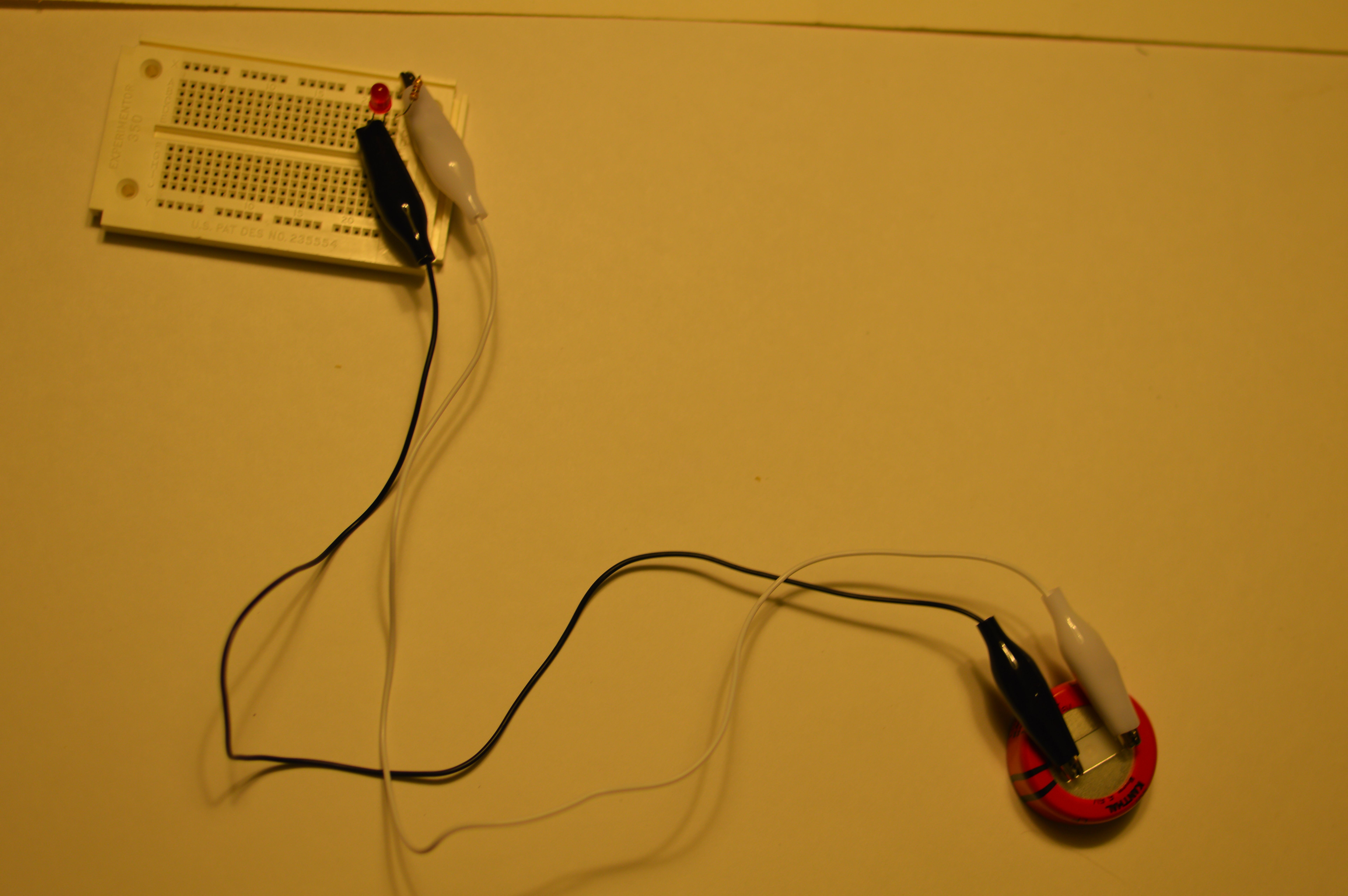
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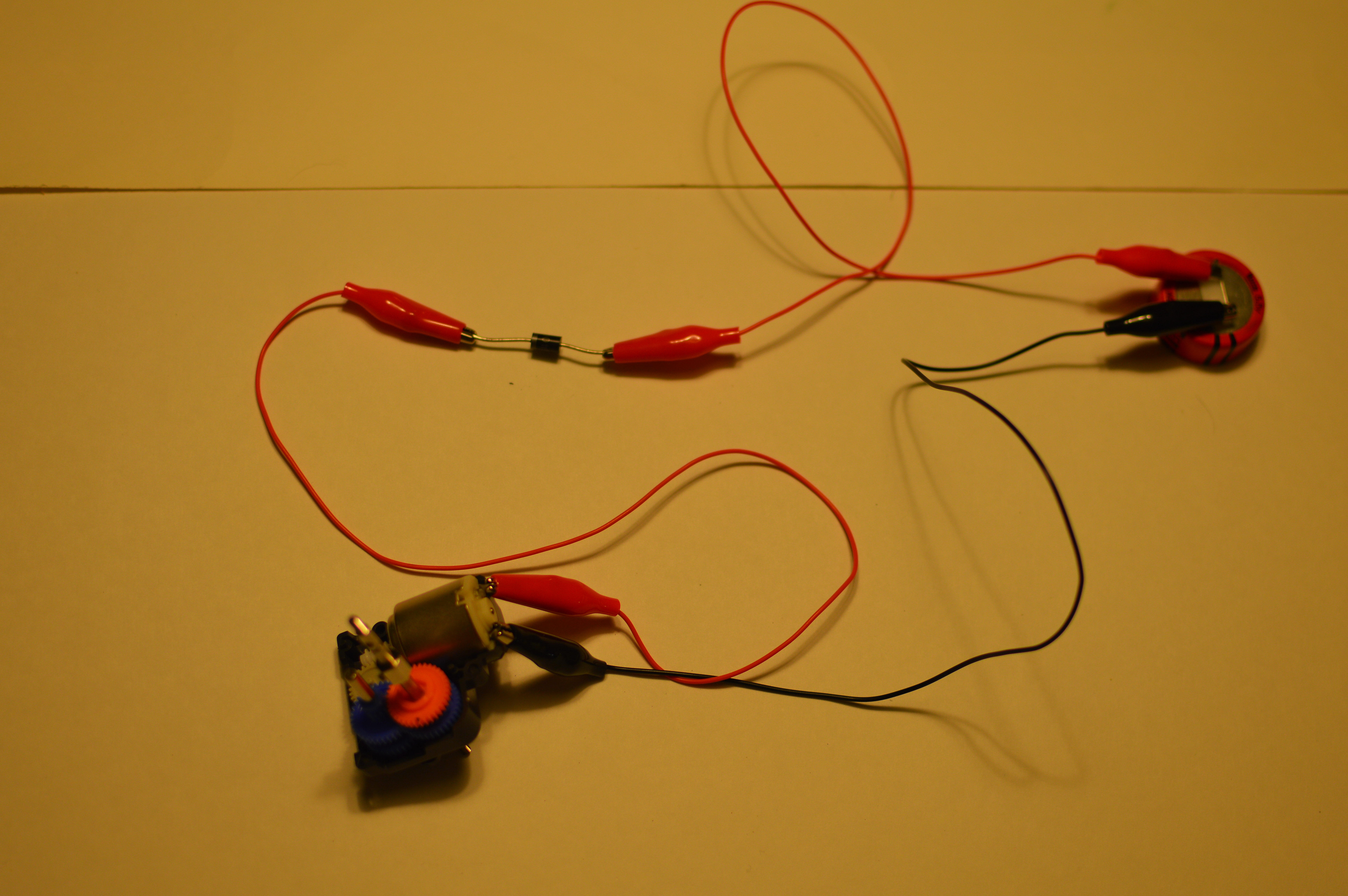

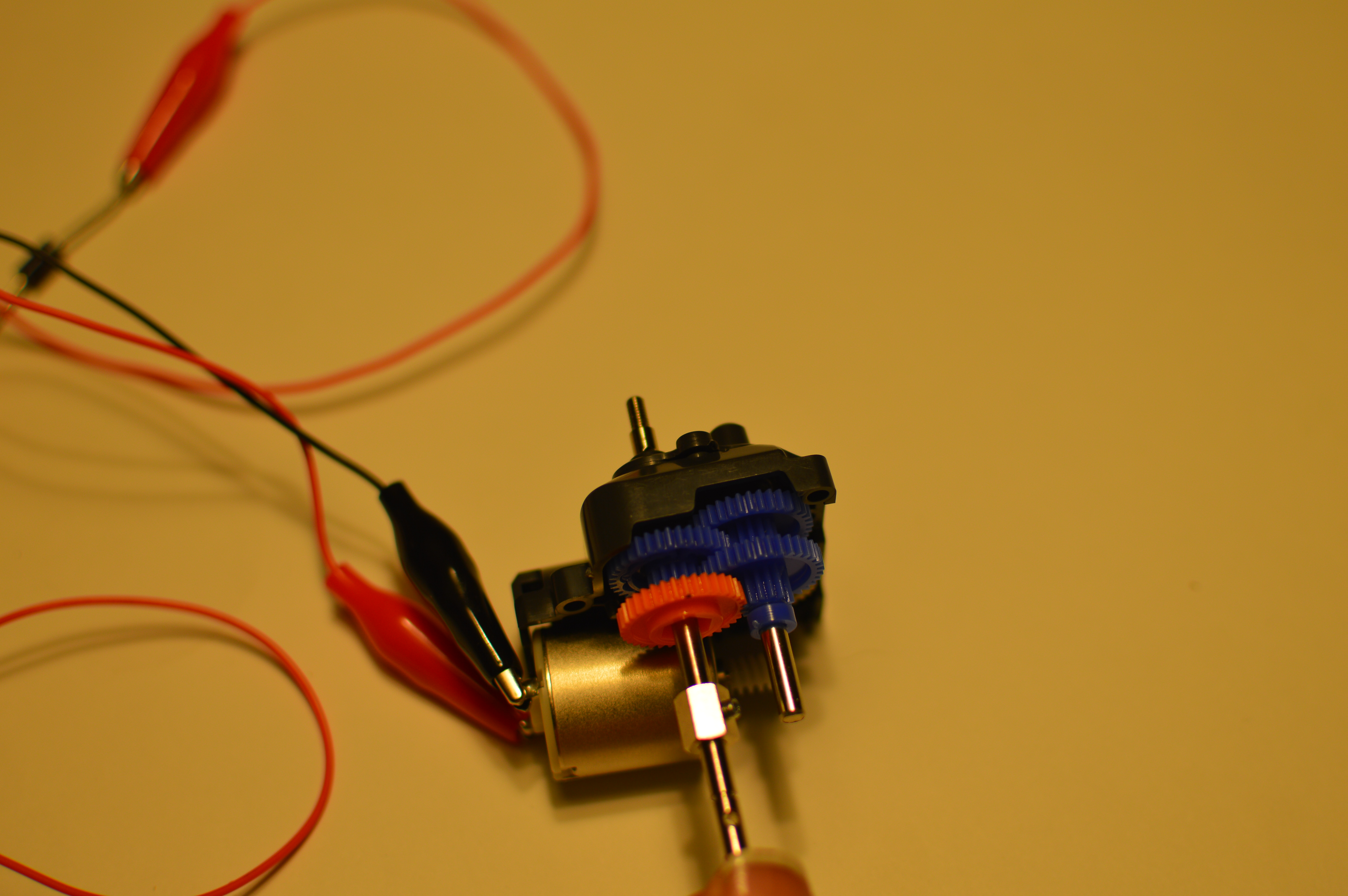

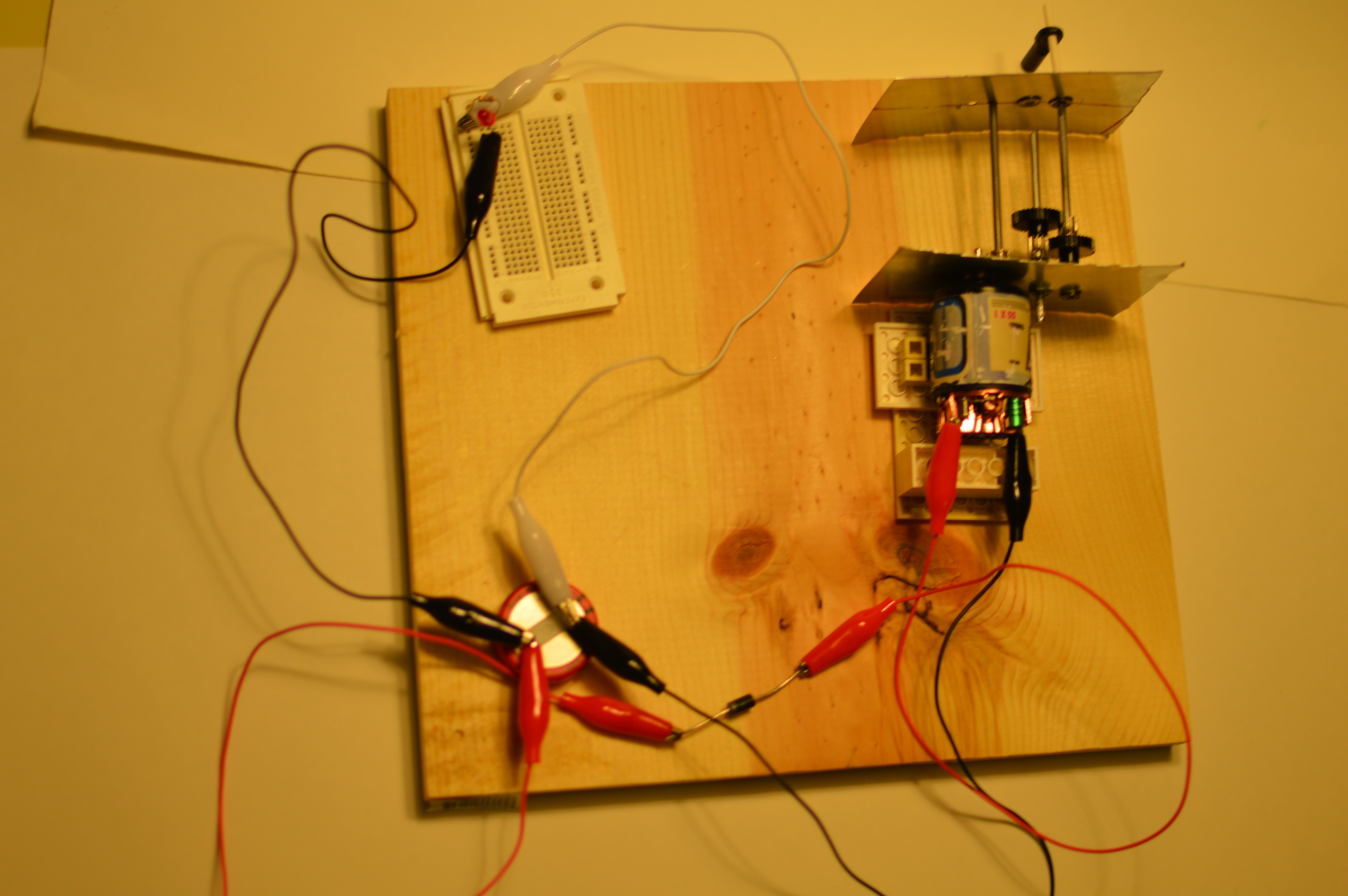

Revolving Door Project Gear Ratio Calculations

$Teeth_{large}$: $Teeth_{small}$	Gear Reduction G_n= # Teeth $_{large}$/ # Teeth $_{small}$	Radius of Large Gear r_1 =.5(teeth/pitch)	Radius of Small Gear r_2 = .5(teeth/pitch)	Gear Shaft Distance r_1+r_2
35:12 Used 3 times	2.92	.36	.125	.485
35:14 Used once	2.5	.36	.15	.51
14:12 Used once	1.17	.15	.125	.275

12 rpm x G_1 x G_2 x …x G_n = Output rpm (12 rpm is international standard for revolving doors)	12 x 2.92^3 x2.5x 1.17 = 873.89 rpm
5800 rpm = 6 volt per minute **966 rpm** = 1 volt per minute	873.89/966 = **.905 volts per minute**