Construction of a Novel Portable Emergency Generator

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Abstract

Across the globe, millions of people rely on various sources of energy to carry out their everyday lives, making energy a salient yet limited resource. Considering renewable energy sources, hand-crank generators convert muscle power into electrical energy, which then can be utilized in power outages or other emergency situations. In my research, I designed and constructed a novel, portable, emergency hand-crank generator. To simplify the construction process, a shaft, pulley, permanent magnet alternator (PMA), switch panel, and charge indicator were all mounted in a compact box along with a 12V battery and power inverter. Second, wires were connected from the PMA to the rectifier, then from the rectifier to the battery. Additionally, twelve-volt power was supplied to the switch bank and power inverter. After construction, the generator was successful. The energy generated from the hand-crank charged the battery, displayed on a central indicator screen. In turn, the battery supplied twelve-volt power to two lights (operated by switch panels), a USB port, and an inverter, which can be used to power small household devices. Ultimately, the entire system can be employed as a power source in emergency scenarios.

Introduction

Across the globe, millions of people rely on various sources of energy to carry out their everyday lives (Pisupati, 2018). Renewable energy, such as hydropower and solar, can be replenished over and over again and will never deplete. In contrast, nonrenewable sources, such as fossil fuels, cannot be easily reproduced and will eventually run out over time (Pisupati, 2018). Considering renewable energy sources, hand-crank generators convert muscle power into electrical energy, which can be used in power outages or other emergency situations (Guide to Hand Crank Power Generators, 2019). The mechanical force applied through the hand-crank creates a current to produce electricity (Rfrene, 2014). In other words, the cranking motion alternates the dynamo, a machine for converting mechanical energy into electrical energy, and

therefore generates power that can be stored in an integrated battery (Guide to Hand Crank Power Generators, 2019).

Considering components in my novel hand-crank generator, the Cat 4-I Neo Core Platinum Permanent Magnet Alternator (PMA) is equipped with a set air gap, providing smooth rotation and a superior, no cogging, startup performance. In general, PMA alternators reduce heat and eddy current with proper electrical form, increasing efficiency (Figure 1) (Table 1) (Hurricane Windpower, 2020). In addition, power inverters convert battery direct current (DC) into alternating current (AC), which then can supply power to household appliances and devices (Zafar, 2019). Trickle chargers maintain battery power and prevent self-discharge by replenishing battery power at the same rate as the self-discharge (Advance Auto Parts, 2020).

In my research, I plan to create a novel, portable hand-crank generator for use in emergency situations such as power outages. In my novel emergency generator, the battery supplies twelve voltage power to two lights (operated by switch panels), a USB port, and an inverter, which can be used to power household appliances. Furthermore, the energy generated from the hand-crank is used to charge the battery, displayed on a charge indicator screen. The generator will include a trickle charger, which can be periodically plugged in to keep the battery fresh over long periods of idle time. In addition, supplementary jumper cables can recharge the battery for extended use by connecting to a vehicle, or they jumper cables can jumpstart a vehicle in case of an unexpected dead battery. Ultimately, the entire system can be used as an emergency generator.

Methodology

A. Purchase Materials

B. Mount Permanent Magnet Alternator (PMA):

1. Using the PMA as a guide, measure and mark three holes in the desired mounting area, indicating bolt location for the alternator.
2. Drill main hole for alternator with a hole saw, using the main center mark in step I.
3. Initially drill pilot holes on the supplementary marks from step I, ensuring the holes align with the PMA. Then fully drill hole.
4. Mount metal brace to support the bottom of the PMA.
5. Mount PMA with bolts.
6. Mount alternator support bracket.

C. Mount Shaft

7. Cut metal braces from flat stock and 1x1 angle to support the drive-pulley shaft and to reinforce the box.
8. Secure 1x1 angle with (4) 10-24 screws
9. Fasten bearings and metal braces with bolts and flat washers.
10. Cut the shaft to length.
11. Insert shaft through bearing.

D. Mount Battery Box

12. Secure wooden mount to raise battery box to proper height.

13. Utilizing an air-powered cut off tool, cut appropriate slices into the battery box, acting as insert slots for zip-tie straps.
14. Insert zip-tie straps without fastening them.
15. Wrap battery strip around battery box, acting to secure the lid.
16. Screw the battery box onto the wooden mount.
17. Place the 12-volt battery into the battery box and fasten it with zip-tie straps.
18. Add the lid to the battery box and secure it with the battery strap.

E. Mount Rectifier

1. Drill pilot hole
2. Screw in rectifier with a 10-24 screw, washer, and nut.

F. Mount Switches

1. Cut a rectangle on the side of the box using an air-saw.
2. Mount in the switch panel with screws.

G. Mount Inverter inside box with Velcro.

H. Wiring

1. Connect three output wires from the PMA to the rectifier.
2. Using 12-gauge wire, connect positive and negative terminals of the rectifier to positive and negative terminals of the battery.

3. Supply 12V power to the switch bank, which distributes power to lights and charge indicator screen.

4. Connect positive and negative wires from power inverter to 12V battery

5. Connect wires from charge indicator to shunt.

I. Mount Charge Indicator

1. Drill hole to insert wires through the box.

2. Feed wires through hole and connect to the charge indicator.

3. Mount charge indicator with Velcro.

J. Fasten handle onto shaft by tightening set screw.

K. Connect a trickle charger to positive and negative battery terminals.

L. Connect jumper cables to positive and negative battery terminals.

Figure 1: I am drilling main hole for alternator with a hole saw.

Figure 2: I am cutting the metal brace to fit shape of box.

Figure 3: PMA mounted in box with alternator

Figure 4: PMA mounted in box: outside view

Figure 5: I am cutting metal braces from flat stock to reinforce box.

Figure 6: Using Bench grinder, I am smoothing the sides of the metal brace.

Figure 7: I am fastening 1x1 angle.

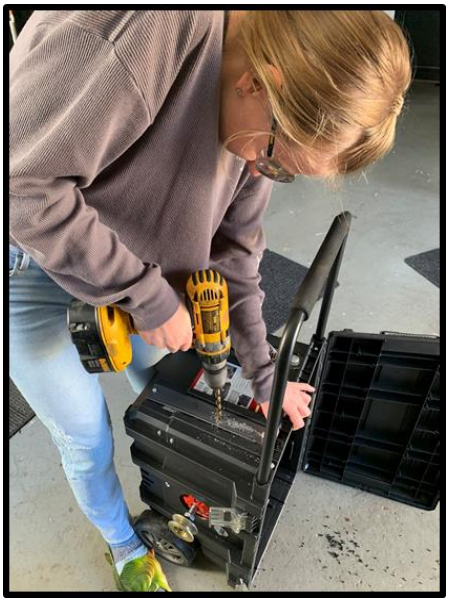

Figure 8: I am drilling holes into the metal braces

Figure 9: I am securing bearings onto metal braces with a wrench.

Figure 10: Using a cut-off tool, I am cutting the shaft to length.

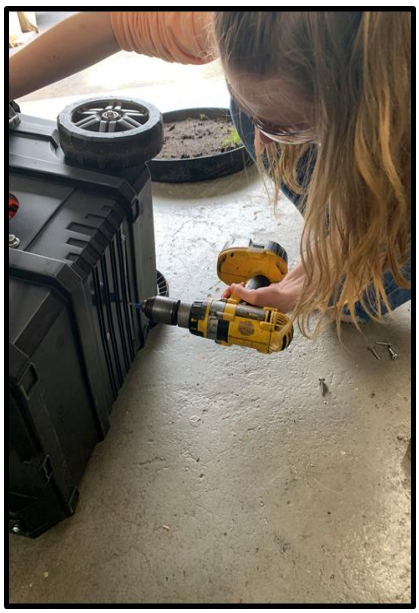

Figure 11: I am securing the wooden mount to raise battery box to proper height.

Figure 12: Using an air-saw, I am cutting a rectangle to insert the switch panel.

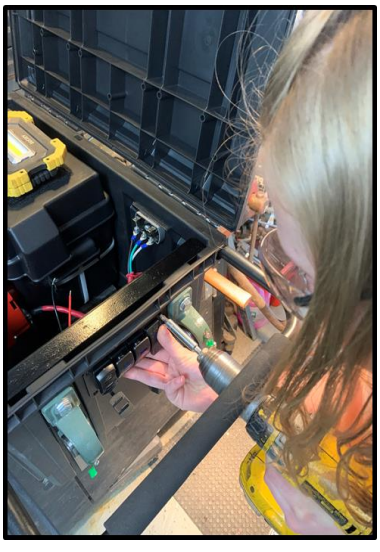

Figure 13: I am mounting the switch panel with screws.

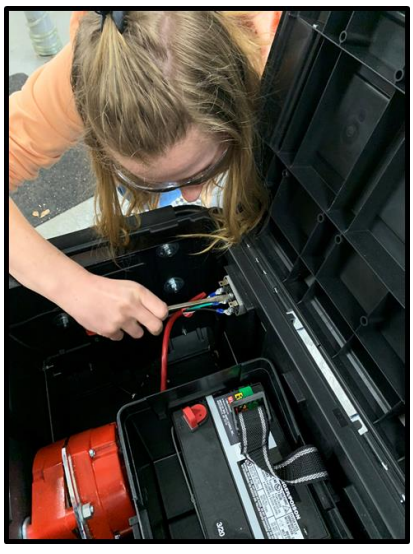

Figure 14: I am connecting the three output wires from the PMA to the alternator.

Construction Notes:

- When mounting the PMA and other components, it was imperative to consider and preserve the shape and build of the box. For instance, it was vital to mount parts on a smooth surface as compared to the ribs and curves.
- In order to retain rigidity and structure, Velcro was used in some cases to prevent cutting a hole in the box.
- Some metal brackets, such as the alternator support bracket, needed to be cut and grinded in order to fit intended application.
- The more the battery is charged, the more difficult it is to spin the hand-crank, preventing the battery from overcharging.

Results

The generator was successful and functioned properly.

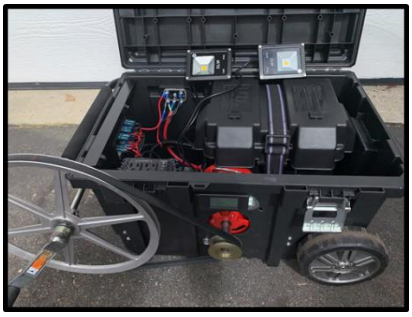

Figure 15: Front view of generator with open lid, featuring lights

Figure 16: Switch Panel. The two left-most switches operate the lights, while the right switch controls the main power.

Figure 17: Front view of generator with closed lid.

Figure 18: Inside of completed hand-crank generator.

Discussion

The objective of this research was to design and create a novel, portable hand-crank generator that can be utilized as an emergency power source. After construction, the generator successfully operated to my hypothesized potential. In my novel emergency generator, the battery supplies twelve-volt power to two lights (operated by switch panels), a USB port, and an inverter, which can be used to power household appliances. Furthermore, the energy generated from the hand-crank is used to charge the battery, displayed on a central charge indicator screen. The generator also includes a trickle charger, which can be periodically plugged in to keep the battery fresh over long periods of idle time. In addition, supplementary jumper cables can recharge the battery for extended use by connecting to a vehicle, or they can jumpstart a vehicle in case of an unexpected dead battery.

This novel generator is applicable in a variety of scenarios, especially when people are not comfortable using gasoline generators, or gasoline generators may not be permitted in condos or apartments. Furthermore, gasoline generators often become un-operational after sitting for

periods of time. Lastly, my novel hand-crank generator would be more advantageous and convenient to use in brief power outages, as opposed to dealing with the hassle of a gasoline generator.

Conclusion

In conclusion, a successful novel, portable hand-crank generator was designed and constructed to be used as an emergency power source in a power outage or other emergency situation.

Acknowledgements

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