USB Charger Based on Gear Train Mechanism

Abhijeet Bisen
Student, Mechanical Engineering, Technocrats Institute of Technology/ Rajiv Gandhi Proudyogiki Vishwavidyalaya, India

***Abstract*- Technology is our means to remain connected. As technologies have become more powerful and capable, their requirement of power has increased correlatively. Lamentably, battery technology has not showing comparable growth. Hence, there is a need for frequent charging. People usually face a common problem in charging their electronic appliances while travelling. My solution to this problem is gear train mechanism-based hand crank charger. Hand crank charger is a device which uses mechanical energy which is converted in to electrical energy through a dynamo and charges the electric appliances. It does not require any electrical energy. Hence, going for this renewable source of energy we can reduce the human footprint on Earth as we are using human effort instead of conventional energy. Light weight gears are used for conversion of mechanical energy from hand crank to dynamo.**

Index Terms- USB Charger, Gear, Dynamo, PCB, Hand Crank Charger, Mechanical Energy.

INTRODUCTION

With ever increasing demand for energy, man has done its utmost in search of the same. Different methods of extracting energy have been experimented with and the best is done to develop them. Out of so many possible energy sources available such as solar, wind, static, hydro, mechanical, etc. Mechanical is most suitable for approximately every situation. It's the easiest and cleanest way to generate power and gear box or gear train mechanism is the easiest way to generate power in less space. One can charge their USB appliances while waiting for their buses at bus stops or at parks in their leisure time. This mechanism goes long back in World War II where it was used to power sirens, search lights, radio, etc. In general, a cell phone battery requires 3 ~ 6 volts dc and 160 ~ 200ma current for charging. Since, we are using a 6volt dc dynamo we will be getting the desired output easily.

DESIGN PROCEDURE

2.1 Components

There are mainly 6 components in this charger. They are: a) Gear Train, b) Hand Crank, c) DC Generator, d) Printed Circuit Board, e) Output Pin, f) Outer Casing

2.2 Properties Determining the Choice of Materials

Selected materials must have ability to possess the necessary properties for the proposed application. Requirements which are needed to be fulfilled are weight, surface finish, rigidity, ability to withstand environmental attack, service life, reliability, etc. Different types of principal properties of materials decisively affect their selection are:

- Physical
- Mechanical
- From manufacturing point of view
- Chemical

2.3 Block Diagram

Fig.1 shows the total block diagram of the project and its operation.

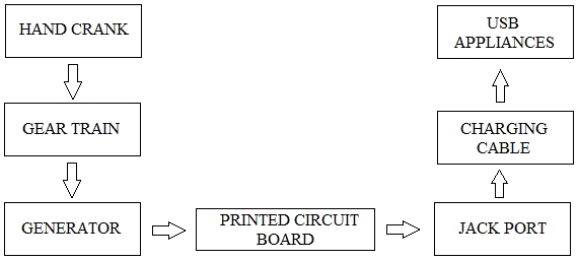

Figure 1: Block Diagram

2.4 Calculations

Total number of gears used = 5

One of them is driver gear and one is driven gear rest are intermediate gears.

Driver Gear: This gear is attached with the hand crank which is to be rotated by hand.

No. of teeth in driver gear = 40
Intermediate gears are set in between the driver and driven gears.
No. of gears = 3
No. of teeth in second gear = 14/40
No. of teeth in third gear = 28/72
Here 12/35 means the upper part (shown on image) has 12 teeth and the lower part has 35 teeth.

Figure. 2: Gear with having lower and upper different no. of teeth Figure. 3: Gear Train

For efficient and smooth run the gears are arrangen in a compound gear train mechanism.
The gear ratio can be calculated directly from the number of teeth on the gears in the gear train. The torque ratio of the gear train, which is its mechanical advantage, is determined by the gear ratio.
Gear ratio = (no. of teeth of gear A/ no. of teeth of gear B)
According to this formula the gear ratio for the whole gear train is calculated step by step below:
1. Gear ratio of driver gear and one intermediate gear = 40/14 = 2.92
2. Gear ratio among two Intermediate (Identical) gears = 40/14 = 2.92
3. Gear ratio among two intermediate(different) gears = 40/14 = 2.92
4. Gear ratio of one intermediate gear and driven gear = 72/28 = 2.50
Therefore, for one full rotation of the hand crank the revolution of the shaft of the motor (which is used as small generator) will be 2.92 x 2.92 x 2.92 x 2.5 = 62.24 (approx.) times.
That is, if the hand crank is rotated one full rotation the motor shaft will rotate 62 times. This will help in calculating the rpm of dynamo.
If the crank is rotated 30 times in a minute then the rpm of motor will be = 30 x 62 = 1860

2.5 Printed Circuit Board

A 5V Mobile Charger PCB 2.2/2.5Amp is used for getting constant output of voltage and current, since the frequency of rotation of crank is difficult to keep constant.

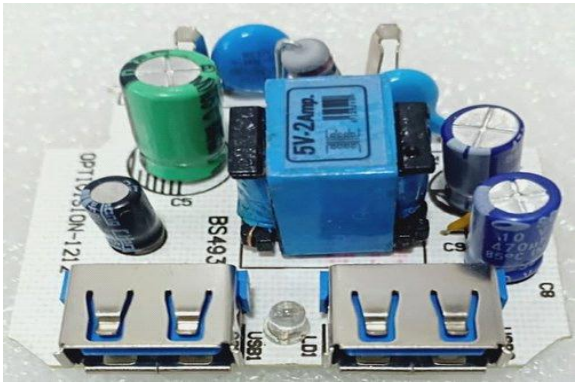

Figure. 3: Printed Circuit Board

RESULT

The maximum experimental reading which is observed at the output port (USB port) is 4.84 vdc. This reading is achieved when crank is rotated at around 125 rpm. The input ac voltage is around 8 v to the PCB which is reduced by the voltage regulator present in the PCB circuit to 4.9 v approximately. The collected data from the setup is given below:

Sl. No.	Dynamo rpm	Input voltage	Output voltage	Output current
1.	90	5.3 v	3.9 v	280 mA
2.	135	7.5 v	4.94 v	340 mA
3.	150	8.1 v	4.96 v	380 mA

Table 1: Experimental Readings

Therefore, the output power of the charger will be (from above given data):
Pout = Vout x Iout (Max.)=(4.96 x 380)W = 1.884 W
Now, the input power will be:
Pin = Vin x Iin (Max.) = (8.1 x 400) W = 3.2 W

CONCLUSION

After reviewing all possible non-conventional energy sources for USB charging hand crank (Mechanical power based) charger found to be the most effective and easiest way to generate small amount of power at any instant. Since, it is independent of climate factor. The compact compound gear train design and its light weight (due to light material of casing and gear) makes it more portable and easier to use. Material like nylon gears makes such things possible. The operational efficiency of this system is about 80% but through more cranking we can achieve sufficient

voltage. But still the output of the system is not enough to charge the latest smart phones. We can later increase its output capacity by using a DC generator of better current rating. A single IC MAX756 which acts as a buck booster can also be used to achieve the same.

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