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Portable Dual Mode Mobile Charger with Hand Crank Generator and Solar Panel

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Abstract

A new method of charging a mobile phone with the help of hand crank generator, and solar panel is being presented in this paper. Solar panel is useful during daylight and hand crank generator can be used at night. So this is a dual mode charger which is operated in either way and both ways do not consume system power. This type of mobile charger is very useful when traveling because it uses solar panel to convert renewable source light into electricity. Mechanical hand crank generator is used which converts mechanical energy into electrical energy and then charges the mobile. No electrical sources are needed for it. Our design uses a compound gear train for transformation of the mechanical energy generated from the hand crank to the generator. For that reason it is convenient as well as economical to use such kind of mobile charger for our mobile phone.

Keywords*: Geared DC Generator; mobile phone charger; solar panel; Hand crank*

1. Introduction

Demand of power energy has never been denied and human are trying their best to produce power energy in efficient way. Thousands of procedure of extracting energy has been investigated and the most effective is done to formulate them [1]. From all the experimented methods of extraction, generation of electrical energy to mechanical energy and from sun tested to be the most effective. Thus we have researched versatile ways of doing that and finally ended up with this solution: Solar powered and Mechanical hand crank mobile charger [2]. In general cell phone battery necessitates 3.6 – 6 Volts dc and 180 – 200 mA current for charging. Since we are using 12 Volts and 600 mA dc generator and a 6 Watt solar panel, we will easily be getting desired output.

2. Components

The following components are in this charger

2.1. Gear Train

It is a mechanical system which is done by connecting several gears on a frame to carry power from one place to another [2]. This is known as gear train. The gear ratio can be calculated directly from the numbers of teeth on the gears in the gear train [3].

The project plan consists of a compound gear train i.e. it has more than one gear present on a shaft, because of high speed reductions. There are two gears in our project. One gear is connected to the hand crank and known as driving gear and the other gear connected to the generator is called driven gear [4]. Two gears are given below.

1) Big Gear: It is a diameter of 2 inch and has 140 teeth
2) Small gear: It is a diameter of 1.2 inch and has 7 teeth

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For rotating mechanism of the generator we used handle and the handle's rotating speed is 5 rpm. It is connected with the big gear. The relationship between big gear and small gear speed ratio comes from the following Equation (1) [5].

$$\frac{\omega_A}{\omega_B} = \frac{R_B}{R_A} = \frac{N_B}{N_A} \quad (1)$$

Here, ω_A = Speed of the hand crank or the big gear

ω_B = Speed of the generator or the small gear
R_A = Radius of the big gear
R_B = Radius of the small gear
N_A = Teeth of the big gear
N_B = Teeth of the small gear

So after putting the values the ultimate speed ratio comes to:

$$\frac{\omega_A}{\omega_B} = \frac{1}{12}$$

The small gear is connected to the dc generator shaft. The big gear is rotated in 5 rpm, so the small gear rotating speed is 60 rpm. If the dc generator produced the power for 60 – 70 rpm speed, the generator produced 7 Watt, 12V and current dropped to 550 mA. So it would take less than 2 hours to fully charge the cell battery. This is the main advantage of using intermediate gears.

2.2. Hand Crank

It is an arm attached at right angles to a rotating shaft [6]. It provides reciprocating motion to or from the shaft. It consists of a handle. The main purpose of the hand crank is to rotate the driving gear [1].

2.3. DC Generator

DC generator converts mechanical energy into electrical energy. When a conductor cuts the magnetic flux, dynamically induced e.m.f. is produced in it according to Faraday's Laws of Electromagnetic Induction. This e.m.f causes a current to flow if the conductor circuit is closed. When the shaft of the motor rotates, there is a relative motion between the permanent magnets and the coils which generates ac current in the coil [7]. The flux associated with the coil is radial in nature. Commutator is used as a mechanical rectifier to convert AC current to DC current [8]. The output value of generator is 12V/ 600 mA.

2.4. Small Solar Panel

Solar cell converts solar energy into electrical energy. The total amount of energy provided by this device is characterized by an output voltage and a current. A number of solar cells are interconnected together to form a required solar panel is known as PV module [9]. It stores power from the sun and lets the mobile phone, iPod, etc. charging. Our Portable Mobile Charger uses small solar panel. Some features of this solar panel are given below:

Our solar panel uses higher efficiency based monocrystalline silicon

Solar panel (Max.)	:	6V/500mA, 6 Watt
Open circuit voltage	:	10.8V
Short circuit current	:	950 mA

Time taken to charge mobile phone using the charger: about 2 hours for typical mobile
Specification of the battery used:

Maker	:	Nokia
Model	:	1208
Capacity	:	1000mAh

Life of the battery will be high as we are using solar panel in this mobile charger. As the battery is 1000 mAh so it would take nearly 2 hours to fully charge the mobile battery.

2.5. Protecting or Blocking Diode

The maximum part of portable devices uses Li-ion batteries for power supply. So a good solar charger strategy is required to charge an internal battery. During the charge cycle this avoids heating the portable device. The fundamental components required to build up for our charger system are: the solar cell, the hand crank generator, a storage battery and a diode to prevent battery discharge to solar cell. Although this is a good starting point, a direct connection between solar cell and battery is not very efficient and should not be implemented [9].

2.6. Regulator

Due to the risk of damage in device permanently, plugging a battery at an unregulated power supply might not be a good idea. Besides, cell operation voltage is defined by the battery voltage summed to voltage drop across the diode, which varies during charge and can't be fixed at the cell's maximum power point. This means that the system is, in fact, wasting some amount of available light energy. A second approach and most applicable approach would be including a 5 Voltage regulator between solar cell and battery. Now the battery terminals are connected to a regulated power supply. This solves the overcharge or permanent damage problems of the charger.

2.7. LED

The LED detects whether enough power is available to charge the mobile phone battery. If LED shows green light then it can be said that mobile phone battery is ready to be charged. If LED shows no light then it will not be charged because the solar panel or the dc generator is not supplying enough power to charge the battery.

3. Basic Block Diagram

The block diagram of our portable dual mode solar charger is shown in the following Figure 1.

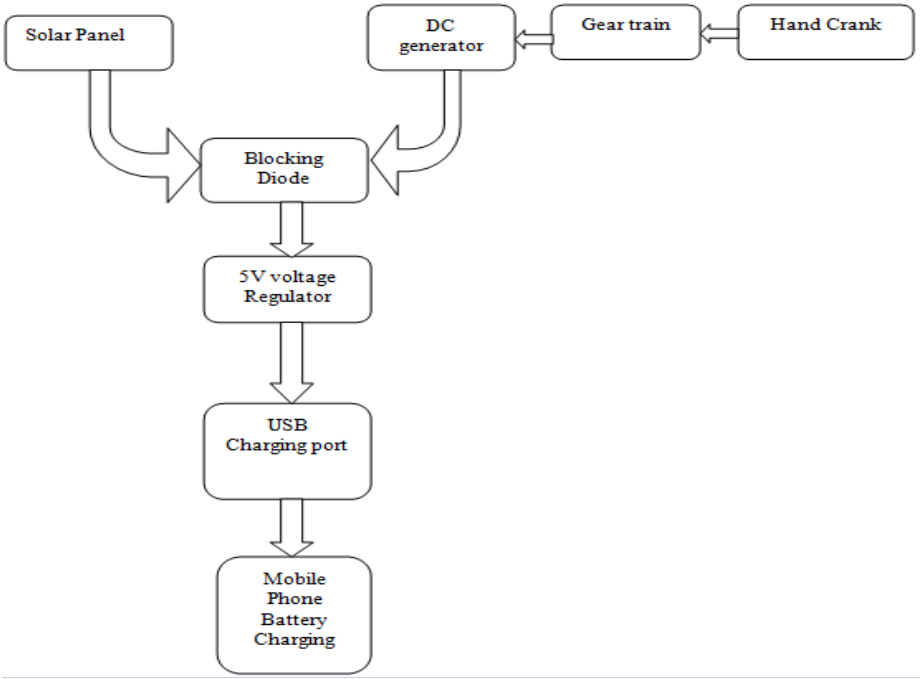

Figure 1. Basic block diagram of dual mode charger

The current from solar panel or dc generator both comes to the blocking diode. The dc generator operates by the hand crank gear mechanism. The blocking diode protects the generator and solar panel from the reverse voltage coming from the battery. And then the current limiting resistor limits the current if accidently huge current enters to the battery. The voltage regulator regulates the voltage to 5V. Finally by USB charging port a battery can be charged with this dual mode charger.

4. Circuit Diagram

In Figure 2 circuit diagram of our dual mode mobile charger with hand crank dc generator and solar panel is shown.

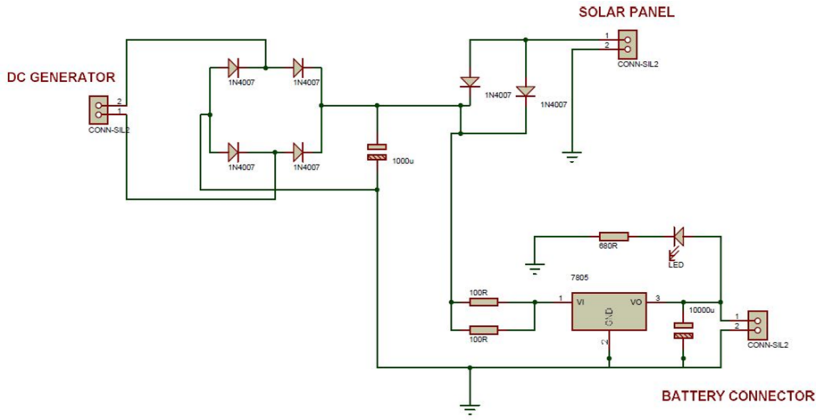

Figure 2. Circuit diagram of dual mode charger

The circuit is mainly assembled on the veroboard. The charging current of the battery comes from the solar panel or the dc generator or both. The current limiting resistor is used to limit the current. And voltage regulator is used for the voltage limiting purpose.

5. Working Mechanisms

Design plan consist of mechanical energy which produced by the rotation of hand crank. This energy used as input to the generator by the gear train. In this device a compound gear train with spur gears is also used. It has one driver gear and one driving gear. This mechanical energy is converted into electrical energy by generator and transmitted it to the regulator and convert the supply to regulated 5V DC.

The power energy produced from the solar panel then transfers to the regulator which then goes to the mobile phone to charge the battery. The purpose of the rectifier is to convert any ac power supply to dc power. For low speed, the DC generator produces DC but when it gets high speed by rotating its gear, sometime it produces voltage spikes [10]. Otherwise for the variable speed it can produce ac. So for the protection a rectifier circuit is used in this device. Formerly the hand crank may not be able to produce desired power. That's why a capacitor of 10000uf is used here for boosting up the voltage purpose. Reverse voltages is blocked by the diode and transfer the resultant voltage to the solar panel to protect the panel. The filtering capacitor is also used with the voltage regulator for filtering purposes. The electrical output supply is given to the LED and output pin connected on the veroboard. The mobile can be charged by connecting the output pin to the mobile.

6. Hardware Circuit

Several hardware picture of the dual mode charger are given below:

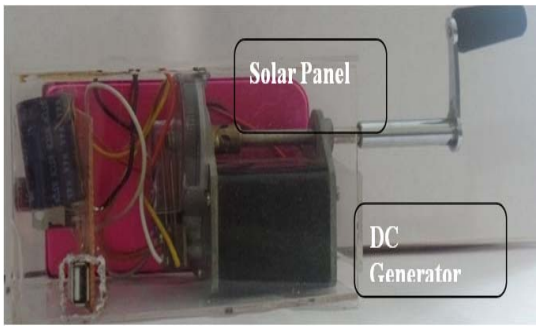

Figure 3. Hand crank and DC generator

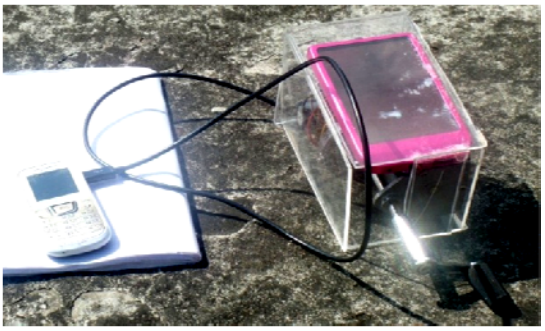

Figure 4. Charging of the mobile using solar panel

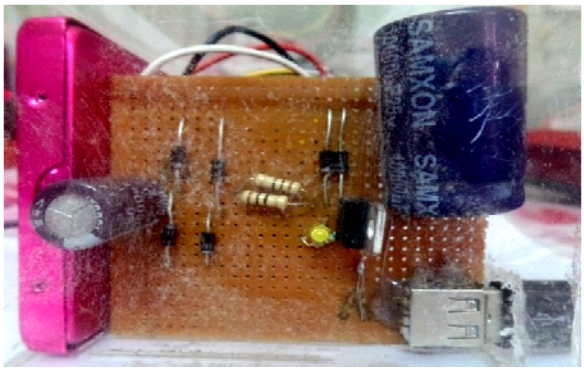

Figure 5. Dual mode charger main circuitry

Figure 3 shows the whole circuit including DC generator and solar panel. Figure 4 shows the mobile phone charging using solar power. And Figure 5 shows the main circuitry of our dual mode charger. All the devices are mounted on a glass sheet to make a better appearance.

7. Mode Comparison of this Dual Mode Charger

Since we are using two types of energy to charge the battery so the comparison of this two modes are discussed here.

Table 1. Various modes

Type	Hand Crank Mobile Charger	Solar Charger
Type of power source	Geared DC generator	Sun PV energy
Type of energy used	Mechanical energy	Electrical energy
Time of using	Any time	At day
Input Voltage	5-18 V	4-7 V
Output Voltage	5 V	5 V

8. Results and Discussion

The dual mode charger is implemented on a NOKIA mobile phone battery to test the operation of this charger. Several data have been taken while the test was running.

Table 2. Speed and Voltage generated relation

Generator Speed (hand crank speed)	Voltage Generated
60 rpm (5 rpm)	12 V
84 rpm (7 rpm)	13 V
120 rpm (10 rpm)	14.5 V
180 rpm (15 rpm)	16 V
216 rpm (18 rpm)	18 V

Table 2 shows the relationship between generator or hand crank speed and the voltage generated from it. The voltage is increasing slowly when the hand crank speed is increasing.

Table 3. Solar panel and battery charging relation

Time	Battery Voltage (V)	Solar Panel Charging Condition
10:30 am	1.7	Charging on
11:10 am	2.5	Charging on
12:00 pm	3.3	Charging on
12:30 pm	3.7	Charging on
01:00 pm	4.2	Fully charged

Table 3 shows the solar panel charging condition with respect to the voltage. When the battery voltage is above 4V then the battery is fully charged. And no need to charge the battery further.

9. Conclusion

We are using human effort instead of ceremonious electricity, so we do not add up with greenhouse emissions. The charger is compact so it can be carried out easily while travelling which fullfills the purpose of this invension. Plastic outer casing maintenance the charger from being damged from the enviroment.The best features of this device is that it is economical and eco-friendly. We can also place a similar tactics in our shoe sole so that the battery can be charged while jogging and there is no need of extra energy for charging.We can also use an epicyclic gear train instead of compound gear train so that large space occupied by the compound gear train can be reduced and the charger can become more paked.

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