Virtual Prototype of Mechanical Hand Crank Mobile Charger

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Abstract— Mobile phone is our means to remain connected. While the phones have progressively got more powerful processors and large touch screen interfaces, their power requirement has increased correspondingly. Unfortunately, battery technology has not been growing at a comparable pace. Hence, there is a need to frequently charge the batteries. While travelling, people face a common problem of charging electronic appliances. Our solution to this problem is Mechanical Hand Crank Mobile Charger. Mechanical hand crank mobile charger is a device that utilizes mechanical energy, converts it into electrical energy and charges the mobile. It doesn't require any electrical source. Also by going for this alternative source of energy we can reduce the human footprint on Earth as we are using human effort instead of conventional electricity. We have used a compound gear train and 6 intermediate gears for transformation of mechanical energy from hand crank to generator. Pro-engineer software for designing the gear train, NI Multisim software for simulation of the circuit and Reverse engineering technique to achieve this solution for the problem.

Index terms— Compound gear train, NI Multisim, Reverse engineering, Simulation.

I. INTRODUCTION

With ever increasing demand for energy, man has left no stone unturned in his search for the same. Many methods of extracting energy have been experimented with and the best is done to develop them. Of all the thus experimented methods of extraction, generation of electrical energy from mechanical energy proved to be the most efficient. So we have explored various ways of doing that and finally landed up with this solution: Mechanical hand crank mobile charger. In general cell phone battery requires 3.6 – 6 volts dc and 180 – 200ma current for charging. Since we are using a 6volt dc generator we will be getting the desired output easily.

II. COMPONENTS

There are mainly 7 components in this charger. They are

a) Gear Train
b) Hand crank
c) DC generator
d) Printed circuit board
e) LED
f) Output Pin
g) Outer casing

A. Gear Train:

Two or more gears are made to mesh with each other to transmit power from one shaft to another. Such a combination is called gear train or train of toothed wheels.

There are mainly four types of gear trains. They are

A. Simple gear train
B. Compound gear train
C. Reverted gear train
D. Epicyclic gear train

Our design consists of a compound gear train i.e. more than one gear is present on a shaft, because compound gear train is used for high speed reductions. The gear connected to the hand crank is driving gear and the gear connected to the generator is driven gear. There are six intermediate gears in between driving gear and driven gear. Intermediate gears are used to increase the speed ratio. By using these six intermediate gears the speed ratio is increased by 74 times i.e., when driving gear rotates with 1 rpm, the driven gear will rotate with 74 rpm. This is the main advantage of using intermediate gears.

B. Hand Crank:

A crank is an arm attached at right angles to a rotating shaft by which reciprocating motion is imparted to or received from the shaft. It consists of a handle. The main purpose of hand crank is used to rotate the driving gear.

C. D.C. Generator:

A DC Generator is a machine which converts mechanical energy into electrical energy. It is based on the principle of production of dynamically induced e.m.f (Electromotive Force). Whenever a conductor cuts 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. The generator used in our design is 6volt DC generator.

D. Printed Circuit Board:

A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks or signal traces etched from. The components on our PCB are Diode, Transistor, 2 Resistors, Capacitor, DC jack and Zener diode.

E. LED:

A light-emitting diode (LED) is a semiconductor light source. An LED is mounted on the PCB to indicate that the Output is being produced when the hand crank is rotated.

F. Output Pin:

Output pin acts as connector between PCB and mobile to transfer the output produced.

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G. Outer Casing:

Outer casing is the outer cover of the charger that is used to firmly hold all the components in their respective positions and protects them from any external ailments. Due to outer casing only all the gears are maintained in meshing condition even when the hand crank is rotated at high speeds.

III. SPECIFICATIONS OF GEARS

Addendum circle diameter of gear = 22.07mm.
Addendum circle diameter of pinion = 8.07mm.
Thickness of gear= 3.00mm.
Thickness of pinion= 4.00mm.
Number of teeth on gear= 25
Number of teeth on pinion = 12
Speed ratio between driving gear and driven gear is nearly 74.

IV. ASSEMBLY

Hand Crank ⇨ Gear Train ⇨ Generator ⇩ Led ⇨ Printed Circuit Board ⇩ Output Pin

V.REVERSE ENGINEERING TECHNIQUE

We employed REVERSE ENGINEERING technique to model our design. Reverse engineering is the process of discovering the technological principles of a device, object, or system through analysis of its structure, function, and operation. It often involves taking something apart and analysing its workings in detail to make a new device or program that does the same thing without using or simply duplicating the original. We have analysed the already existing design to come up with this solution. We have replaced the gear train with our new design of it and the generator with 6 volt DC generator. We have done all the calculations of gears with the help of existing metal gears. We are making use of the hand crank and printed circuit board of the existing design.

VI. MODELING

We have modelled our design by using PRO-ENGINEER (PRO-E) software. PRO-E is a 3D solid modelling application used worldwide by Engineers to design, develop, and analyse products. We have given mechanical input to driving gear so that the driven gear is rotated by power transmission through intermediate gears. Gears are shown in grey colour and pinions are shown in green colour. By using these six intermediate gears the speed ratio we achieved is nearly 74. When the driver gear rotates with 1 r.p.m then driven gear will rotate with 74 r.p.m. We have done simulation of circuit in NI MULTISIM software. NI Multisim is an electronic schematic capture and simulation program. Multisim is used to draw the circuit design and simulate the output for the given different inputs. We have designed our circuit by using this software and simulated it. The input given is 6volts dc and we are getting the output as 5.6 – 5.7 volts dc which is sufficient to charge the mobile battery.

The screenshot of the gears designed in PRO-E is shown below.

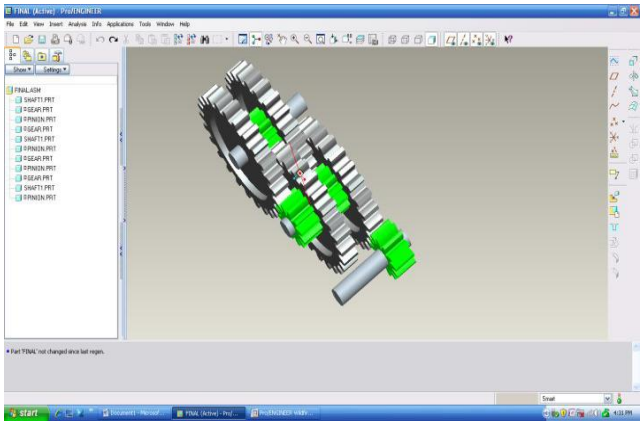

Fig. 1 Compound Gear Train

The screenshot shown below gives the picture of circuit designed and simulated in Multisim software.

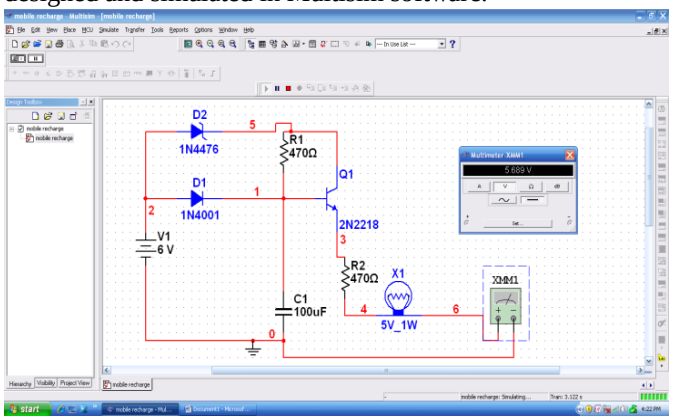

Fig. 2 Circuit Diagram

VII. WORKING MECHANISM

1) The hand crank is rotated so that mechanical energy is produced.
2) Mechanical energy is given as input to the generator by using gear train.
3) A compound gear train with spur gears is used. The compound gear train has one driver gear, one driven gear and 6 intermediate gears.
4) Generator converts mechanical energy into electrical energy and transfers it to PCB. Generator is mounted on PCB.
5) The electrical output supply is given to the led and output pin mounted on PCB.
6) By connecting the output pin to mobile, the mobile battery can be charged.

VIII. RESULTS & CONCLUSIONS

1) The result obtained from the simulation performed in Multisim software gave an output result of 5.689 Volts against an input of 6 Volts which suffice the needs of charging a battery.
2) As we are using human effort instead of conventional electricity, we do not sum up to the greenhouse emissions.

3) The charger is compact so that it can be easily used while travelling for which it is mainly designed.
4) As we are using plastic gears and outer casing the maintenance of the charger is very easy i.e. there is no need for providing lubrication.
5) It is economical.
6) It is eco-friendly.
7) We can also place a similar mechanism in our shoe sole such that while jogging the battery can be charged and there is no need to spend extra energy to charge it.
8) We can use an epicyclic gear train in place of compound gear train so that large space occupied by compound gear train can be reduced and charger can become more compact.

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