DESIGN AND FABRICATION OF A SELF CHARGING BICYCLE

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Abstract
In this paper, the designing and fabrication of a self-charging bicycle is described. The pollution due to automobiles is increasing with every passing day and the use of electric vehicles for short distance travelling will help to reduce the pollution to some extent. These electric vehicles need to be recharged at a power point which is again very time consuming. An attempt is made to eliminate or reduce dependency on recharging from main supply by introducing a Self-Recharging Mechanism. The model consists of five separate parts, namely: the Battery, the Dynamo, the DC motor, controller and charging system. The BLDC motor uses electric energy from battery to provide torque to wheels and the battery receives electric energy from the Dynamo. This paper outlines system requirements to successfully develop and deploy an electric bike, focusing on recharging of the battery using the pedaling motion and the operational concepts, of the e-bike. A Self Charging Electric Bicycle based on a Brushless DC Motor drive which has high efficiency, zero pollution, clean and convenient, is Designed and Implemented in this Project.
Keywords: Electric Bicycle, Self-charging, DC motor, Battery, Dynamo

Introduction

The electric bicycle offers a cleaner alternative to travel short-to-moderate distances rather than driving a gasoline-powered car. The idea of a motorized bicycle isn't a recent conception and has been around for over a century. Until 1895, the electrical bicycle created its place in history. That year, Ogden Bolton developed a powered bicycle with a six-pole brush-and-commutator DC hub motor mounted within the rear wheel [1]. E-bikes use rechargeable batteries and the lighter varieties can travel up to 25 to 32 km/h, depending on the laws of the country in which they are sold, while the more high-powered varieties can often do in excess of 45 km/h. In some markets, such as Germany, they are gaining in popularity and taking some market share away from conventional bicycles [2], while in others, such as China, they are replacing fossil fuel-powered mopeds and small motorcycles [3]. Bikes with Kinetic Energy Recovery Systems (KERS) by means of Flywheel Energy Storages (FES) are also used where the energy is stored in a flywheel instead of a battery using chain and sprocket mechanism [4]. Sreevalsan S Menon et al [6]. KERS on a bicycle is used to store the lost energy during pedaling and use it to propel the bicycle forward. Such a bicycle when tested, showed that around 30% of the energy delivered can be recovered by the system [5]. It is observed that in the context of efficient energy use, electrical energy in electric drives plays a fundamental role. High efficiency energy storage systems permit energy recovery, peak shaving and power quality functions. Due to their cost and the importance of system integration, the need for a correct design based on technical-economical optimization was felt and thus a method to design was designed which showed a centralized storage system for the recovery of the power regenerated by a number of electric drives [6]. It is also possible to bring together several components and ideas to achieve a common goal i.e. to make it possible to build a bicycle with 3 separate charging sources [7]. A self-charging electric bicycle can run for a longer distance than ordinary electric vehicles. Also it makes for a low cost transportation. The drawback of e-bike requiring frequent charging form EB supply can be excluded from this. For charging the battery that runs the motor a dynamo is used which stores energy in the battery by converting the pedal power. The resultant was that this e-bikes running cost is very low, when compared to other sources of energy [8].

Design: There are numerous key parts incorporated into the design of the bicycle. They comprise of a Lead corrosive battery, engine controller, dynamo generator and a brushless DC motor. The force throttle controller is utilized to trigger the capacities for changing speed, keeping the velocity steady, and killing the engine. The force hotspot for the framework has a DC battery source yield 24V. The battery is interfaced with the engine controller square. The engine controller controls all the utilitarian capacities and is the focal part of the framework. The fundamental necessity for the control is to manage the amount of force transferred to the engine, particularly for DC motor. The main components of the design are as follows

a) Bicycle.
b) Brushless DC motor.
c) Dynamo.
d) Lead acid battery.
e) Bridge wave rectifier.
f) Sprocket (4 nos.).
g) Chain.

The design requirements for the projects were as follows

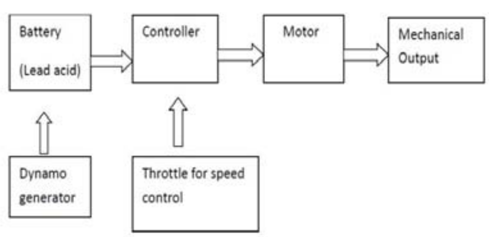

Fig 1: Flowchart of design requirements

Taking into consideration, these requirements, a model was developed using computer aided design software. The design is as follows

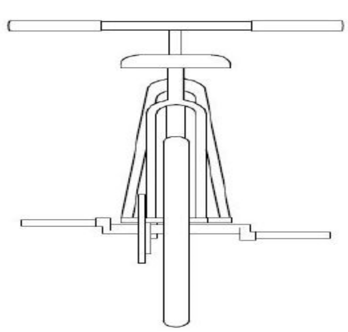

Fig 2: Front View

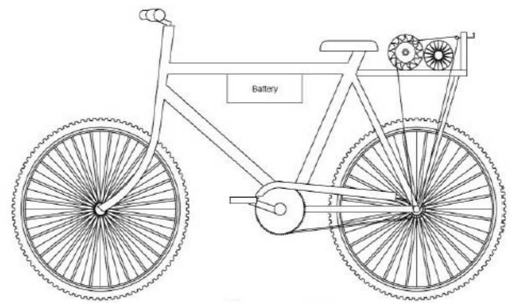

Fig 3: Side View

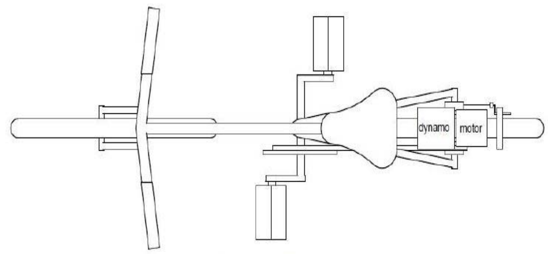

Fig 4: Top View

Calculations:

For gear ratio for the motor, the number of teeth is equal on both the sprocket (motor and back wheel).

∴ Gear ratio = 1:1

For dynamo, number of teeth on larger sprocket attached to the pedal is T_1= 44

Number of teeth on the sprocket is T_2= 18

∴ Gear ratio = $\frac{T_1}{T_2} = 2.44$

Torque of motor:

For the DC motor we used,

Voltage = 24V

Power = 350 watt

Rotation = 2650 rpm

Rated torque = 2.5 Nm to 4 Nm

Efficiency (%) = >75

When the motor is loaded,

RPM (N) = 200

Power (P)=350 Watt

Let, Torque = T

∴ $P = T\omega = \frac{2\pi N}{60}$

$\Rightarrow T = 16.71\ Nm$

Fabrication: Suitable freewheel sprocket gears are fixed to the shafts of the dynamo and BLDC motor. The rear wheel of the bicycle is disassembled from the frame in order to fix an additional freewheel sprocket gear to the wheel axle. The modified wheel is then re-assembled. The carrier of the bicycle is modified by welding four metal strips to the carrier frame to house the motor. Suitable holes are drilled into the metal strips to fix the motor with the aid of nut and bolt. Now, a chain of adequate length is used to connect the freewheel sprocket gear of the motor and the additional rear freewheel sprocket. The sprockets are so installed such that the motor drives the rear wheel in the forward direction. (Anti-clockwise). Another metal frame is fabricated and welded to the front V-frame of the bicycle to house the battery, dynamo and the controller. Since the ready-made front axle was short to incorporate a new freewheel sprocket, a longer front axle was prepared from mild steel in the workshop. This front axle with a new freewheel sprocket is assembled to the bicycle so that it rotates effectively while pedaling. The dynamo is fitted to the fabricated frame with the help of nut and bolt. The freewheel sprockets of the dynamo and front axle are aligned and fixed. The freewheel sprockets of the dynamo and the freewheel sprocket of the front axle are connected by a chain of suitable length. One of the battery and the motor speed controller are fitted on the fabricated frame of the front V-frame of the cycle. The second battery is fixed on the carrier frame by welding two metal strips and tightening it with nut and bolt. A twist type throttle is fitted into the right handle bar in order to regulate the speed of the motor. It can also make or break the connections to the battery with the help of a switch provided on the throttle. Appropriate electrical connections are made using insulated electrical wire (1mm and 2.5mm) to connect the battery, dynamo and motor through an intermediate controller mechanism.

Fig 5: Placement of the dynamo in the frame

Fig 6: Overall placement of all the parts

Fig 7: View from the left side

Conclusion: After the model was tested, it was found that the speed of dynamo should be more to charge the battery. For this the gear ratio for the dynamo has to be changed to increase its speed. This project brought together several components and ideas to achieve a common goal: to prove that it is possible to build a bicycle with self-charging capability. The project will prove as a great academic tool for understanding the working of KERS as well as the e-bike and potential of self-charging it for the future endeavours of the coming generations.

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