SOLAR POWERED ELECTRIC BICYCLE

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13 MAY 2009

I hereby declare that I have read through this report and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation & Automation)"

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Supervisor's Name : ……

Date : ……

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This Report Is Submitted In Partial Fulfillment Of Requirement For the Degree Of Bachelor In Electrical Engineering (Control, Instrumentation & Automation)

Faculty of Electrical Engineering
Universiti Teknikal Malaysia Melaka

May 2009

"I hereby declare that this report is a result of my own work except for the experts that have been cited clearly in the reference."

Signature : ……

Name : ……

Date : ……

APPRECIATION

First of all praises be to Allah S.W.T, The Most Merciful for His Guidance and Blessing. I am indebted to the numerous people who have contributed their time, effort, advice, help and constructive criticism throughout my research and development of my Final Year Project 2. I also would like to express my sincere gratitude an appreciation to my family for their unending support and not forgotten to my Final Year Project supervisor, Mr. Kyairul Azmi Bin Baharin who guide and support me for this final project. Sincere thanks go to all my fellow classmates for their unconditional support and understanding. I would like to say thank you to everbody that involved in this final year project directly or indirectly for the good and excellent collaberation. Finally I would like to thank the Faculty of Electrical Engineering (FKE) of Universiti Teknikal Malaysia Melaka (UTeM) for giving me this medium and opportunity to produce and develop the given project.

ABSTRACT

Bicycles offer extremely efficient, pollution-free transportation for urban and suburban areas and the addition of electric drive eliminates the sweat, extends the range and helps older riders. However, we must recognize the problems that restrict ridership to a hardy few. For the rider, these includedanger from autos, stop and go driving on streets not designed and maintained for skinny tires, and hard weather. And for the local government, bike lanes take up valuable space without providing revenue. Presented here is generally of a solar powered vehicle which is specific on conventional bicycle. Actually, the usage of solar panel is for an alternative source to replace the fuel consumption. This invention will be in small scale which is (1:4). The preferred embodiment consists of a standard children electric bicycle, plus an electrical propulsion system and a solar charging apparatus. The preferred embodiment is normally powered by a motor and electrical switch that can be operate at any time. The electrical propulsion system consists of DC electric motor and a plurality of batteries. The recharging part consists of battery charger and solar panels. The analysis part will be enclosed about the characteristic of battery and solar panels and also the connection between these two power sources in this invention.

ABSTRAK

Basikal merupakan salah satu pengangkutan yang efisyen, bebas pencemaran untuk kawasan bandar mahupun luar bandar dan penambahan penggerak elektrik seperti motor elektrik mampu mengurangkan penat , menambahkan jarak perjalanan dan dapat membantu warga-warga emas. Walaubagaimanapun kita harus sedar bahawa masih terdapat beberapa masalah yang timbul dalam keadaan ini. Contohnya, bagi seorang penunggang basikal masalah yang dihadapi termasuklah tiada laluan yang khas bagi penunggang basikal dan mereka lebih terdedah kepada bahaya pemandu-pemandu lain di jalan raya. Seharusnya pihak kerajaan menyediakan laluan khas supaya penunggang basikal dapat mengayuh dengan selamat. Secara amnya, projek yang akan dibangunkan adalah kenderaan solar iaitu basikal. Penggunaan panel solar di dalam projek ini adalah bertujuan sebagai alternatif kepada penggunaan minyak yang semakin lama semakin berkurangan. Namun, projek ini akan dibangunkan pada skala yg kecil iaitu (1:4). Komponen asas terdiri daripada basikal elektrik kanak-kanak yang mempunyai komponen-komponen elektrik dan yang paling utama adalah penggunaan panel solar. Projek yang akan dibangunkan ini digerakkan oleh motor arus terus, bateri dan juga suis elektrik. Bahagian pencas semula terdiri daripada pengecas bateri dan panel solar. Bahagian analisis lebih menumpukan kepada ciri-ciri bateri dan panel solar dan hubungkait di antara kedua-dua sumber kuasa ini dalam pembangunan projek ini.

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LIST OF FIGURE

LIST OF ABBREVIATION

DC	-	Direct current
V	-	Volt
FYP	-	Final Year Project
PV	-	Photovoltaic
A	-	Ampere
mph	-	Miles per hour
kph	-	Kilometer per hour
km	-	Kilometer
m	-	Meter
W	-	Watt
Wh	-	Watthour
Kg	-	kilogram
LV	-	Low Voltage

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 Introduction

In the modern societies, the increasing needs of mobility means sometimes increasing the number of vehicles circulating. Ambient concerns, as for instance the local pollutant emissions for the atmosphere, influence also, in nowadays, the technical decisions related with all kind of vehicles. In this context, new alternatives to the existing internal combustion engines are mandatory. So, vehicles with solar powered system seem to be an interesting alternative. Therefore in this context, solar powered electric bicycle is now developed for fulfill the necessity.

1.2 Problem statement

The problem statements of this project are:

a) The recently street bicycle do not have solar powered that can be an alternative replacing the usage of fuel.
b) It is difficult to buy a photovoltaic cell because it is too expensive.
c) Need to find the suitable specifications of motor that can be use depends on the application of the ordinary street bicycle.
d) How to optimize the usage of the photovoltaic cells on this electric bicycle.

1.3 Project objective

The main objectives for this project are:

a) To develop an electric bicycle by using solar energy that can be used for leisurely rides and as a vehicle where parking traffic are the problems.

b) To study the relationship and characteristic between solar energy and electrical propulsion system.

c) To compare the characteristics and performance between solar electric bicycle and conventional electric bicycle.

d) To analyze the effect of solar energy on the performance of DC motor.

1.4 Scope of project

This project will focus on how to apply the photovoltaic (PV) panels on the electric bicycle in term of:

- Flat road condition and angel less than 30^0 road
- The performance of the DC motor for a specific distance that will be determined afterward.
- Analyzing the application of solar panels on the electric bicycle.
- Analyzing the usage of rechargeable battery on the electric bicycle.

Because of the high-cost and need a lot of time to analyze and develop an actual size of conventional electric bicycle, the size of the bicycle had been **scale-down to (1:4)**. The dimensions of the bicycle is about length (0.64 m) x width (0.33 m) x height (0.33 m). The unload weight about 2 kg (4.4 lbs) and the maximum load that can be support is about 25kg (55.11 lbs).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews existing project created to get an idea about the project design, conception and any information that related to improve the project. There are many creations and innovations of projects that have been done by other people with differences concept and design. This chapter also covers the researches related to the subject. This will provide a clearer understanding of the system and its design. This project is all about the solar powered electric bicycle operation system and design.

2.2 Previous project (1)

Early 2001, David Clay was built a solar-electric bicycle. On this solar and human powered rig, he rode from San Francisco, California, to Carbondale, Colorado, arriving just in time to start a summer of classes at Solar Energy International. In the summer of 2001, he went to China, and continued solar cycling around the world. [15

2.2.1 Ultimate test

The trip was also the ultimate test for developing the solar cycle. After the first 30 miles, he realized that he needed a stronger PV mount. After 100 miles, he realized that he needed brakes for the trailer. After 1,000 miles, he realized that he needed a

trailer with spoke wheels. And after 1,500 miles, he finally decided that he needed a more powerful motor.

2.2.2 Performance

The rig has a 24V DC system. In full sun, the array of four Solarex MSX Lite modules produces 4 to 5 A. His trailer weighs 190 pounds (86kg) empty, and he pulled an additional 85 to 100 pounds (39–45 kg) of gear. On flat ground, he can cruise at 18 mph (29 kph) without pedaling, with the motor drawing 13 amps.

He then tested the range of the bike on flat ground, with an unloaded trailer and a 150 pound (68 kg) rider, from full battery to empty battery (100% SOC to 20% SOC). With no pedaling and no sunshine, it has a range of 25 to 30 miles (40–50 km). With no pedaling, but with good sun, the solar cycle has a range of 35 to 40 miles (55–65 km). When pedaling, the rider‘s fitness level becomes the only limit.

On his journey, he averaged 45 miles (72 km) a day on his travel days, pedaling consistently at a moderate pace, averaging 12 mph (19 kph). Typically he would start the day (late morning) with the batteries at about 24.5 volts, and finish the day at dusk at about 24 volts. He would often reach 25+ volts by midday, because he didn‘t rely heavily on the motor until later in the day, when he was tired, and also more confident in the battery‘s state of charge.

2.2.3 Components

This solar cycle consists of a cargo trailer with a canopy of PV. The trailer is manufactured by Bikes At Work, and is 2 feet wide by 6 feet long (0.6 x 1.8 m), plus a couple feet in the trailer tongue. It has an impressive 300 pound (135 kg) capacity,

and is mostly aluminum. The trailer carries the batteries, which power a 24 V pedal-assist electric motor on his bike.

2.2.4 Motor

Originally I had a pedal-assist motor setup called the US Pro Drive (model B-CTI-3VP-K), made by Currie Bicycles. It is a 400 W brush-type motor, with an integrated controller. The motor is mounted on a drive train that mounts onto the spoke base of the rear wheel, and provides a 14 to 1 reduction, with the help of a built-in planetary gear. It is a very tidy and compact setup, but I found that the motor would overheat on a daily basis, even when it was running below 16 A (400 W).

2.2.5 Solar bicycle load

Load	**WH / Day**	**Weight (lbs.)**
Motor (DC)	300–800	20
Boombox	10–50	5
Computer	0–70	7
Cell phone	0–5	1
Total	310–925	33

Table 2.1 Solar Bicycle Load

2.2.6 Solar bicycle cost

Item	**Weight (lbs.)**	**Cost (US$)**
4 Solarex modules, 120 W	32	620
Bikes at Work trailer, 6 foot	35	400
Scott motor, 1 hp	20	250
2 Dynasty batteries, 33 AH	60	200
Curtis controller, 175 A	5	200
E-Meter	1	200
Miscellaneous	35	100
Amcamex inverter, 140 W	2	90
Charge controller, 10 A	1	55
Battery charger, 2 A	5	50
Total	**196**	**2165**

Table 2.2 Solar Bicycle Cost

2.2.7 Schematic Diagram

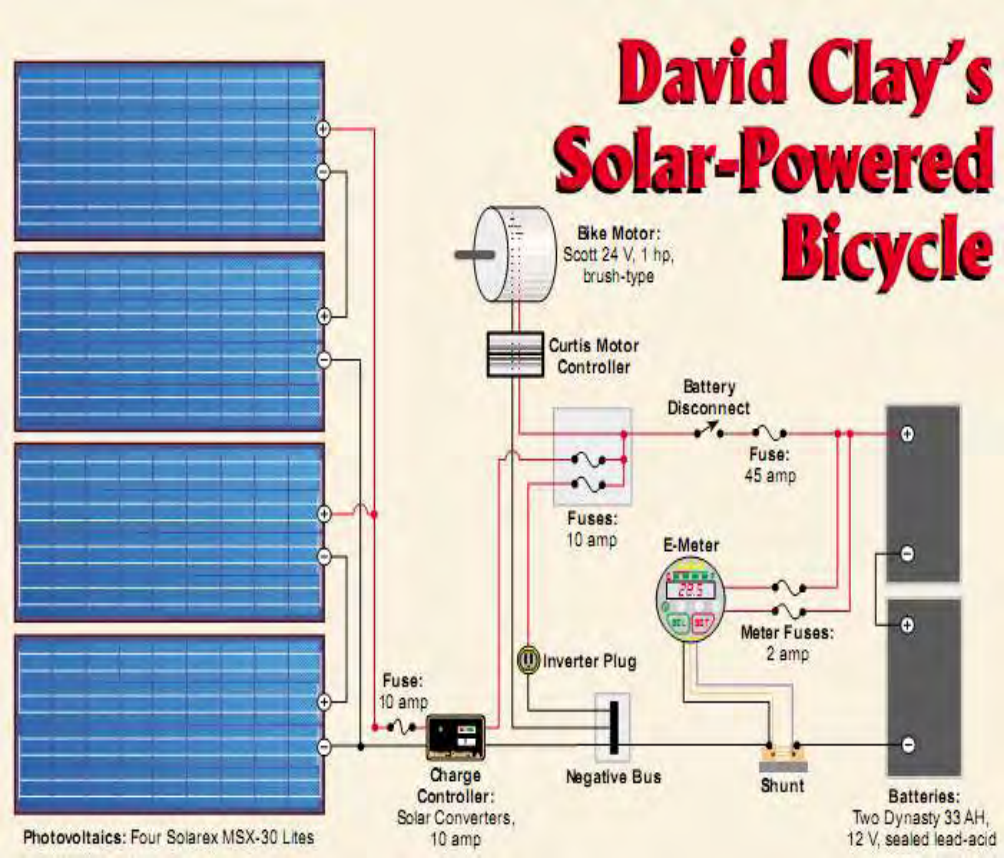

Figure 2.1 Solar Powered Bicycle

2.3 Previous project (2)

On the April 29, 1993, Henry M.Gannon was proposed an electric and pedal driven bicycle with solar charging. This invention relates to an electric propulsion system for a multi-wheeled vehicle including though not limited to a bicycle. [12]

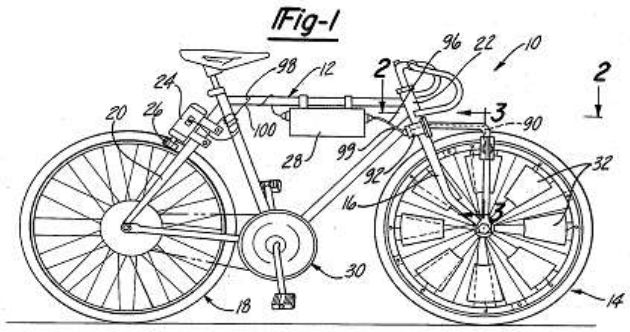

Figure 2.2 Side plane

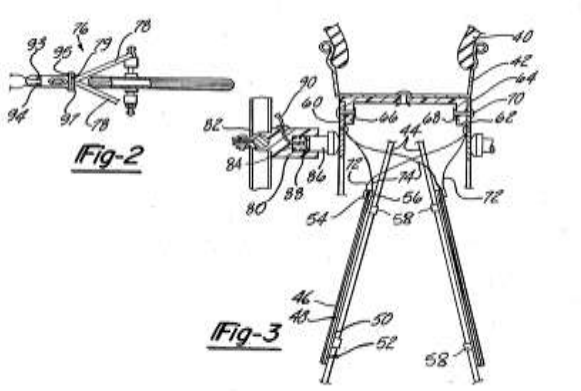

Figure 2.3 Fragmentary and sectional view

2.3.1 Background of the invention

2.3.1.1 Field of the invention

The present invention relates generally to vehicles having an electricity operated load device and more particularly to such a device employing a PV cell for charging the electrical power source or operating the load device.

2.3.1.2 Description of the Prior Art

There are many previously known forms of motorized vehicles. In particular, it has also been previously known to provide a motor means for driving a bicycle in order to supplement or replace manually driver pedal mechanism provided on such vehicles. Although such bicycles are often powered by a small internal combustion engines, it has been known to employ electric motors powered by a battery source.However, the disadvantage of battery powered propulsion units is that the battery discharges and must then be recharged or replaced. Consequently, the vehicles is unavailable for use during recharging of the battery unless the battery is removed and replaced by a fully charged battery.

2.3.2 Summary of the present invention

The present invention overcomes the disadvantages by providing a solar energy conversion device carried by the vehicle. More particularly, PV cell are secured to exposed sides of wheels of the vehicle. Preferably, the cells are aligned at an angle to a plane which is normal to the axis of the wheel. Accordingly, the cells are disposed in direct contact with sunlight even during normal operation of the vehicle.

A bicycle is particularly well adapted for incorporation of the power source charging means of the present invention. In the preferred embodiment of the present invention, a plurality of PV cells are secured to the spokes of both sides of at least one of the bicycle‘s spoked wheel. In this manner, the PV

panels are supported in the desired angular alignment. In addition, the positive and negative conductors of the PV panels can be easily wired to annular rings secured to the rim of the bicycle wheels. Moreover, the bicycle fork which supports the axle for the bicycle wheel can also be used to support electrical conductors adjacent the annular rings for the purpose of electrically connecting the PV panels with the load device. Preferably, the PV panels are connected to a battery through a voltage regulator which prevents overcharging of the battery.

2.3.3 Brief description of the drawing

The present invention will be more clearly understood by looking in the several views and in which:

- **FIG. 2.2** is a side plane view of a bicycle constructed in accordance with the present invention to include solar energy conversion devices

- **FIG. 2.3** is a fragmentary view taken substantially along the line 2-2 in **FIG. 2.2**

- **FIG. 2.4** is an enlarged sectional view taken substantially along the line 3-3 in **FIG. 2.2**

2.4 Previous project (3)

On the February 8, 1982, Thaddeus Novak was proposed a solar powered vehicle. In a bicycle having an electric motor drive including a battery power source, an apparatus for automatically recharging the battery comprising at least one photovoltaic panel secured to the wheel of the bicycle. The conductors of the PV

panel secured to the wheel of the bicycle. The conductors of the PV panels are electrically connected to annular rings secured to the wheels so that a plunger supported adjacent the annular ring to the appropriate wire conductors at a junction box which applies the current to the battery and the electric motor. [11]

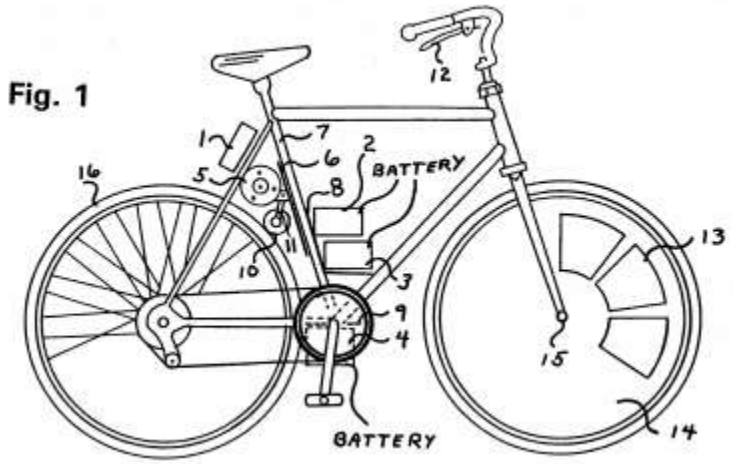

Figure 2.4

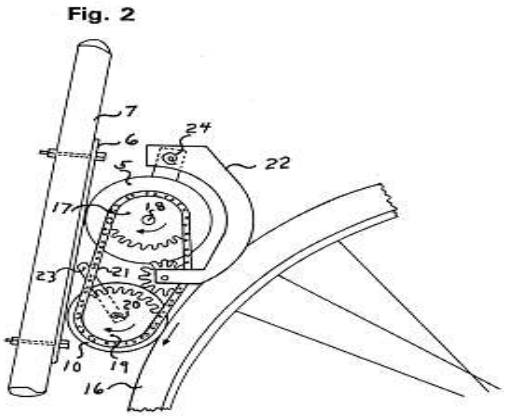

Figure 2.5

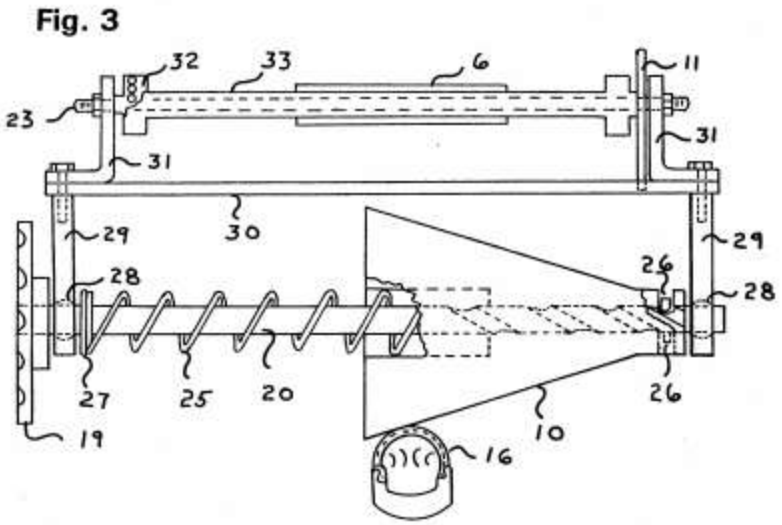

Figure 2.6

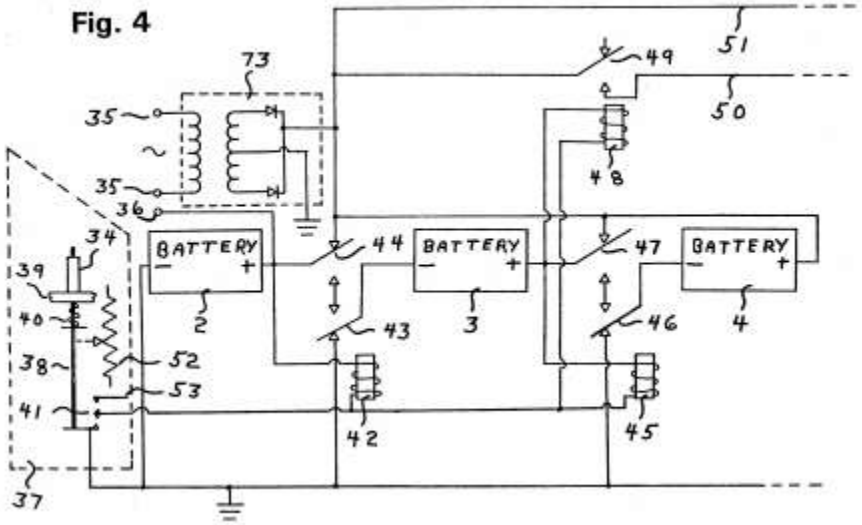

Figure 2.7