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A

Project Report

On

"Hybrid E-Bicycle"

Submitted by

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Under the Guidance of

Dr. B.N. Chaudhari
Head of Department
Dept. of Electrical Engineering,

in partial fulfillment for the award of

BACHELOR OF ENGINEERING

DEPARTMENT OF ELECTRICAL(EL/ECTRONICS & POWER) ENGINEERING

P.E.S. COLLEGE OF ENGINEERING

Nagsenvana, Aurangabad-431001

(2021)

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(Approved by AICTE - New Delhi, Recognized by Govt. of Maharashtra,Affiliated to Dr. Babasaheb Ambedkar Marathwada university,Aurangabad)Nagsen vana, Aurangabad – 431001 (M. S)

CERTIFICATE

*This is to certify that the Project report entitled "**Hybrid E-Cycle", ** which is being submitted to **Dr. Babasaheb Ambedkar Technological University Lonere, Maharashtra State**, in partial fulfillment of the requirements for the award of '**Bachelor of Technology**'in **'Electrical (Electronics & Power) Engineering**. This Project is submitted by '**Mr.Shivshankar gadeodhe() ,Mr.Sameer Gaikwad(),Mr.Akash Waghmare(),Mr.Ajay Gaikwad(),Mr.Vikas Dhaware(),Mr.Vaibhav Jite(),Mr.Sagar Kakle()** under my supervision and guidance.*

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ACKNOWLEDGEMENT

I am greatly indebted forever to my guide **Dr.B.N.Chaudhari** Head of Electrical Engineering Department, PES College of Engineering, Aurangabad for his continuous encouragement, support, ideas, most constructive suggestions, valuable advice and confidence in me. He gave me complete freedom to pursue all my interests and also provided so many exciting directions to explore. Behind the freedom he gave, there is his strong belief that the best work is done. In addition to his technical powers, what helped me a lot was his passionate approach to research, his intrepidity in attacking important hard problems, his enthusiasm for exploring new areas, and his emphasis on bold imagination and creativity. His advice of simultaneously working on a variety of problems ensured that work never became boring. His openness to my decisions and confidence in my abilities made me reach much higher goals than I could have imagined. His infectious cheerfulness, attitude of dealing with challenges, and patience with random door-knocks would dissolve the worst of the stress. Proud to be his student, I hope to keep in touch with his amazing mentor and friend.

I express my gratitude and sincere thanks to **Dr. B. N. Chaudhari** Head, Department of Electrical Engineering, PES College of Engineering, Aurangabad for his constant motivation and support.

I sincerely thank **Dr. A. P. Wadekar** Principal PES College of Engineering, Aurangabad for their continuous encouragement and active interest in my progress that they gave throughout the work.

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LIST OF ABBREVIATION

Abbreviations	**Illustration**
AC	Alternating current
DC	Direct current
BLDC	Brush less DC motor
W	Watt
V	Voltage
P	Power
Ah	Ampere hour
Wh	Watt hour
I	Current
Li	Lithium ion

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CHAPTER 1
INTRODUCTION

Background

Energy crisis is one of the major concerns in today's world due to fast depleting resources of petrol, diesel and natural gas. In combination with this, environmental decay is an additional factor which is contributing to the depletion of resources which is an alarming notification. Our paper proposes the solution for this above perilous problems. The system which we innovated is the Electric Bike. This project has various benefits both to the members of the team and also external benefits thereby making awareness of using alternative modes of transport. The Electric Bike which works on the battery that is powered by the motor is the general mode of transport for a local trip. The solar panels can be alternative source for this by adding it to the system. The Electric bike which will be running on battery, the power is supplied by the motor, thereby supplying this power to drive the other gear components. The main purpose of using this E-bike is that it is user friendly, economical and relatively cheap. The efficiency of this system undeniable compared to conventional modes of transport. The following table shows the specification of various electric bikes used in few countries.

Table : Specifications of E-Bike in various countries :

Country	**Type of bike**	**Speed limit in km/hr**	**Watt**	**Weight in kgs**	**Age required in yrs**
Australia	Pedal	25	250	None	None
Canada	Hand	32	500	None	Various
China	P/H	30	200	20	None
Norway	Pedal	25	250	None	None
Israel	Pedal	25	250	30	14
UK	Hand	27	250	40	14
Taiwan	Hand	25	200	None	None
US	Hand	25	750	None	None
China	P/H	30	500	None	None

What is e Bicycle ?

The Electric bike is a bike which is driven with the help of battery which is coupled to electric motor.

Main principle: It works on the principle that the electromotive force of an A.C. motor which receives electrical energy stored in D.C. battery is converted with the help of D.C. to A.C. converter.

Working medium: Here for the motivation of prime mover the chemical reaction takes place from which an energizing current is evolved which is responsible for the working.

Problem of Statement

It is observed from the study of this project, This project is proposed in order to design the electric bicycle that use for the travelling and can be used in long distance. The designing of the electric bicycle is included of the frame design, motor control and gearing system design and the riding comfort for the rider. The design is done in group but with separate task and objective, which is each of people done different part for the electric bicycle. In this proposal, the motor control and gearing system design will be proposed.

The motor that would be used for the gearing system need to be done research and analysis so that the suitable motor for the electric bicycle can be choose. Research and analysis for the motor is needed because it one of the main component of the electric bicycle in order to move. The limit of the motor that would be used in the project also must be noted, because it will tell how much the load or speed the motor can withstand when heavy duty task are applied on the bicycle. The torque of the shaft also must be calculated which is will be used as the reference of the motor speed on the gearing system.

The type of motor that will be used for the electric bicycle is one of the important thing or element that can influence the speed, duration of the electric bicycle can move with the assistant of electric bicycle that was chosen. Besides that, the type of motor that were be used also important in selection of power supply. This is because; each motor has its own specific power or voltage that the motor used. Even the same type of motor, it power usage still has differences because of it differences in specification

Objective of Project

E-bikes use rechargeable batteries that can travel up to 25 to 45 km/h, much faster than most people would cycle, getting you to your destination quicker and in better shape. In a nutshell they offer low cost, energy efficient, and emission-free transportation which also has physical and health benefits.

E-bike project promotes clean and energy efficient vehicles, electric bicycles and electric scooters (common name “E – bikes”), for delivery of goods and passenger transport among private and public bodies such as delivery companies, public administration and citizens in Indian urban areas, as an alternative to “conventionally fossil fuelled” vehicles.

The project actions are directed towards E-bike market uptake and promotion of policies that stimulate the usage of E-bikes in urban transport.

Scope of Study

The scope of this project is to study of Hybrid E-bicycle and develope a e-bicycle using minimum cost and high efficiency In this we are using different kind of components and developing E-bicycle. It will help to reduce CO2 in environment by replacing conventional bike .

The E-bike market was valued at USD 22.83 billion in 2019, and it is expected to witness a CAGR of 11.84 %, during the forecast period, 2020-2025. ... In 2019, by propulsion type, pedal-assisted e-bikes dominated the market and accounted for a significant share of the global market.

Thesis Outline

The thesis is organized into 5 chapters namely the introduction, literature reviews, methodology, simulations and results analysis, conclusion and recommendation.

Chapter I: discuss the background and general idea of the proposed project. The objective and scope of this project are state in this chapter.

Chapter II: conducts a detailed literature survey on the work done in Hybrid E-Bicycle. The chapter also includes hardware and software requirement of this project.

Chapter III :In this chapter we discuss about System Development of our project "Hybrid E-Bicycle" and explain each and every component of the project with image.

Chapter IV: In this chapter we discus about Performance analysis of the project.

Chapter V : Conclusion and future scope of the project we discus about the future of the this project and conclusion of the this project.

CHAPTER 2
LITERATURE REVIEW

Introduction

This chapter will be stressed on the literature review of related system. The main purpose of this chapter is to analyse, identify and make conclusion based on the research. A literature review means a collecting related data, analysed business process, identify underlying patterns and create the conclusion. Another description of the literature review is a systematic, explic it and reproducible method to identifying, evaluating and synthesizing the existing body of completed and recorded work produced by researcher, scholars and practitioners. In order to develop a successful project, the current systems are identified. The system of conventional electric powered bicycle, solar system and its connection have been analysed. Studies of these systems are significant to develop a valid, reliable and efficient upgrade project. The Literature Review part acts as a mean to discover which methodology should be chosen in developing this system.

Facts and Findings

Facts and findings establishes what the existing system does and what the problems are, and leads to a definition of a set of options from which users may choose their required system. This section will be discussing about the domain of this project, the existing system and finally the other techniques that applicable to be used while developing this project. It focused on the how to design and develop the project systematically according to the requirement of minimize the functional of conventional project. In the other situation, these will be describing any element or method which is useful to be used for the purpose of searching and gathered useful information in developing this project.

Domain

Currently, electric powered bicycle that was studied for this project only uses a battery to get the electric powered supply by recharge it using conventional way. Electric powered bicycle only depends on power that charge in battery to make it functions unless using the manual way to move it. The project is wanted to change the way a battery charge to get the electric power and generate electricity to move the bicycle with optimum energy.

Electric Powered Bicycle

An electric powered bicycle carries batteries or fuel cells that deliver electric power to a motor that is coupled to either wheel. In most electric bicycles the rider can choose to use muscle power to deliver all, part, or none of the propulsion power required to maintain his or her adopted travel speed. Some models even sense your pedal pressure and command the motor to deliver more power whenever you pedal hard. Many electric powered bicycles are specifically design and build for travel. Average travel speed, when compared to pedalled-only bicycles, can be increased by 8 to 10km/h (5 to 6 mph) above the speed an average person could travel by pedalling.

Previous Project

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. The trip was also the ultimate test for developing the solar cycle. He realized that the bicycle needed a stronger PV mount after 30 miles traveling. Next, brakes needed for the trailer after 100 miles and after 1,000 miles the trailer needed with a spoke wheels. After 1,500 miles, powerful motor need to cover the performance of bicycle that remains constantly. Performance of the bicycle is produce by a 24V DC system. 4 to 5 A can be produce in full sun by the array of four Solarex MSX Lite modules. His trailer weighs 190 pounds (86kg) empty, and he pulled an additional 85 to 100 pounds (39–45 kg) of gear. He can cruise on the flat ground at 18 mph (29kph) without pedalling, 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). It can cruise in range of 25 to 30 miles (40–50 km) without pedalling and sunshine. The range is increase to 35 to 40 miles (55–65 km) when it cruises with a pedalling and sunshine. When pedalling, the rider‟s fitness level becomes the only limit.

1895 Ogden Bolton Jr. (6-pole hub motor)

S. H. Roper’s never really had any success. At the end of the 19th century there were only two promising propulsion systems: those based on oil and those based on electricity. Engineers were mostly working on carriages, which would have soon turned into proper cars. During those years, another American inventor decided to build a bike with an electric motor. His name was Ogden Bolton Junior. We know very little about him: he registered a patent in an American office in 1895, and that’s all we know.

Ogden Bolton’s idea was simple but quite interesting: he installed an electric motor on a bike’s rear wheel hub. It was a DC motor with 6 poles, it could take up to 100 amps from a 10 volt battery. The battery was placed under the horizontal tube of the frame. There was no gearing system so we can imagine it had a very high torque and a low battery life (there weren't pedals to help the motor either). We don't know if these vehicles were ever produced or even how common this kind of ebikes were in general. What we know is that there already was an ongoing debate about electric bikes. In an American magazine of the time, we can read a debate between favorable and contrary opinions. Some thought that the demand for these bikes would have grown a lot in the years to come, and some thought that true cyclists loved the physical activity and wouldn't want to let the pedals go. Like it often happens, they were both right.

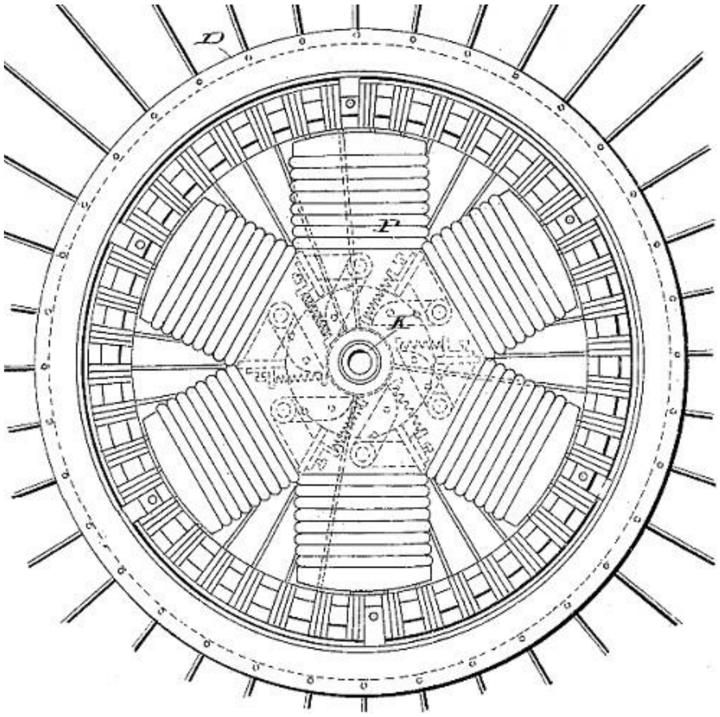


Fig 2.3.1: An image from the patent Ogden Bolton registered in 1895

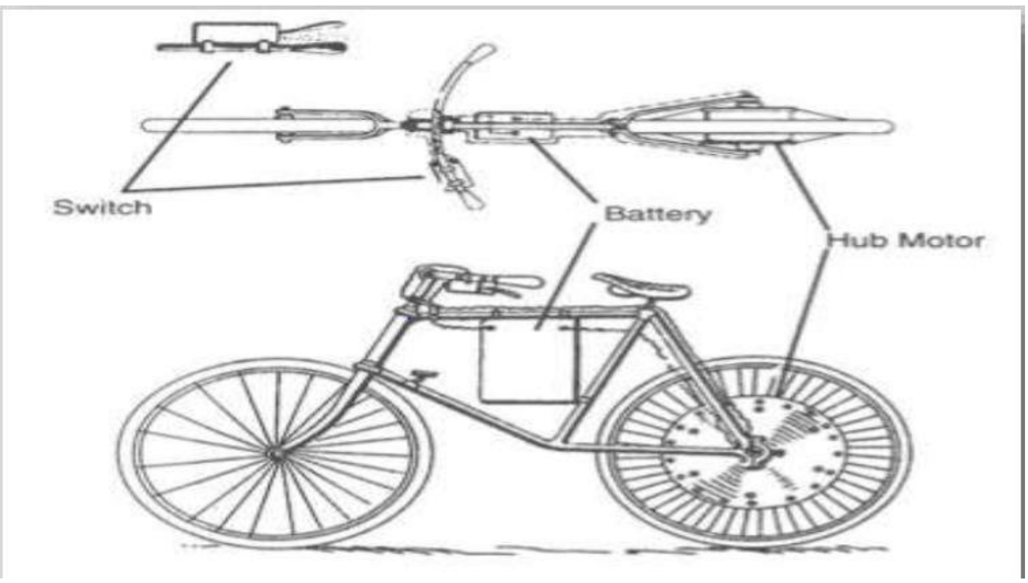


Fig 2.3.2: 6 Pole hub motor mounted on cycle.

1897 Hosea W. Libbey (Double electric motor)

Be it known that I, HOSEA W. LIBBEY, a citizen of the United States, residing at Boston, in the county of Sufiolk and State of Massachusetts, have invented certain new and useful Improvements in Electric Bicycles, of which the following, taken in connection with the accompanying drawings,is a specification. The object of my invention is to produce a bicycle to be propelled by electricity generated by primary batteries and in motors therefor. The invention consists of the novel features of the same, as will be hereinafter fully described, and pointed out in-the claim. Referring to the accompanying drawing Figure 1 represents a side view of a bicycle embodying my invention. Fig. 2 is a plan or top view of same. Fig. 3 is a view of a double electric motor embodying my invention. Fig. 4; is a face View of the field-magnets. Fig. 5 is a face view of'the armatures. Fig. 6 is a transverse section of the battery. A represents the front steering-wheel, and B the rear driving-wheel,which is formed with a duplex tread, so that the vehicle will have three points of rest, whereby it will be maintained in a vertical position. I prefer to employ a wheel constructed according to a patent granted me and dated January 24, 1893, No. 490,891. The front or steering wheel A is mounted in a fork and is operated by handles in the ordinary manner. The rear or driving wheel B is mounted in a fork that is preferably vertical, the front and rear forks being connected by a frame O, preferably of the loop pattern. Near the lower part of the loop two side pieces 0 are secured, upon which the battery D rests. This battery is preferably of similar construction to that shown in Letters Patent No. 586,689, issued to me the 2d day of April, 1895, only in this case the battery is made double-that is, with a central partition (Z. (See Fig. 6.) The batteries are supplied with the exciting fiuid, such as diluted sulfuric acid, from a tank, reservoir, or hollow seat E, of saddle form, said fluid being conducted to the tube F, supplying the batteries by a flexible tube f. A small nozzle 6 is fitted at the rear of the seat, through which the tank or reservoir is filled with the exciting fiuid. This nozzle is closed by a screwcap. The 1 negative wires G of the double battery are connected to an electric controller H, from which wires I run to thedouble motor J, and the positive elements are connected with the motor by wires K, the circuits being formed or broken by means of an upright rod L, fitted at its upper end with a wheel Z in front of the seat E. The motor D consists of a series of central straight permanent or field magnets M, the poles of which are arranged to alternate, and a series of armatures N on each side, each series consisting of a number of horseshoe-magnets n, passed through a plate 2), but insulated therefrom, and coils n on the ends of each of said magnets 01, the plate 19 being secured to the driving-shaft Q, on which are socured commutators R B, one for each series of armatures, to the brushes of which commutators the wires from the spools of the armatures are connected and also the wires from the field or permanent magnets in the ordinary manner, so as to throw the current alternately through the north and south poles of the magnets of the arl'natures and the fieldmagnets, so that they will act to repel each other. On the outer end of the shaft Q are secured cranks S, which by connecting-rods T are attached to cranks U on the rear driving-wheel B, so that as the armatures are rotated a corresponding movement is communicated to said driving-wheel. On each side of the front portion of the frame is secured a foot-rest V, and the machine is fitted with a brake of the ordinary or any desired construction. It will be seen that by this construction a very compact vehicle is produced, and by having the battery divided by a longitudinal portion d and any ordinary means for connecting and disconnecting the wires therewith the vehicle can be driven by either side or by both sides of said battery, as may be desired. Thus only one half of said battery may be used on level roads and both halves employed when climbing a hill, and by employing the rear double-treadcd wheel for the driving-wheel a double amount of traction is obtained. Thus the vehicle is more easily propelled. Instead of cranks and connecting-rods IOO , of an electric battery and motor thereon,said motor comprising a series of straight, parallel, central, permanent field-magnets having their poles arranged alternately with each other, a shaft having its axis concentric with the magnets, a plate upon the shaft 011 each side of the magnets, a series of armatures for each plate, each series of armatures consisting of a pair of horseshoe-magnets passed through and insulated from the plates, a coil upon the inner end of each of the horseshoemagne'ts, a commutator for each series of armatures, the brush of each of Which engages with the central magnets, and means for transmitting the motion of the motor to the driving-Wheel, substantially as set forth.

Hosea W. Libbey of Boston invented an electric bicycle (U.S. Patent 596,272) that was propelled by a “double electric motor.” The motor was designed within the hub of the crankshaft axle. This model was later re-invented and imitated in the late 1990s by Giant Lafree electric bicycles.

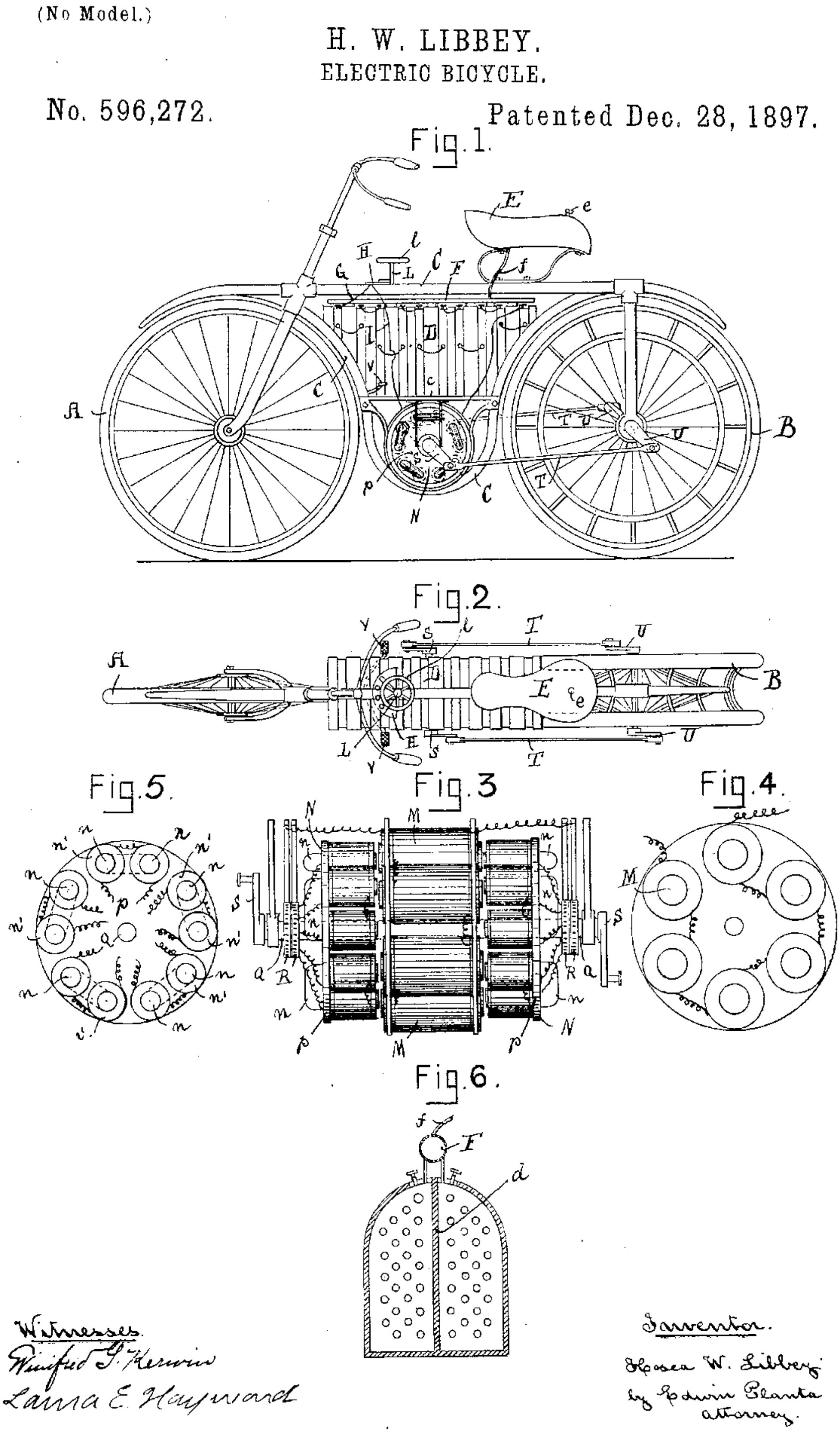


Fig 2.4: double electric motor by H.W. Libbey

1898 Mathew J. Steffens (Driving belt)

In 1898, Mathew J. Steffens issued a patent of an electric bicycle that was operated by a belt that was placed on the periphery of the back wheel and also around the motor (Figure4). The slots on the wheel can prevent the belt from slipping away. Anyway, this kind of propulsion system is very creative.

Following the belt drive system, an idea for a friction drive came in reality. In 1899, John Schnepf introduced a bicycle which used a pulley that rest on the top surface of the rear wheel (Figure5). The pulley rotated with the help of the motor and in turn propelled the rear wheel. In 1969, A. Wood Jr was inspired by the invention of Mr Schnepf and turned it to a more complex friction system consisting of 4 different motors (Figure6). Each one of them was pushed to the front wheel.

In 1946, Jesse D. Tucker assigned a patent for a motor with internal gearing and with the ability to freewheel. Due to the creative design of Mr Tucker, the cyclist can choose whether to use pedals in combination or without combination of the electric motor.

Nowadays, with the help of other invents, such as torque sensors, power controls, new batteries and better hub motors, and advanced technology, electric bicycle has become a big industry, with the fact that there are roughly 120 million e-bikes on the roads of China, and in USA and Europe, the number of electric bicycles sold are in millions now.

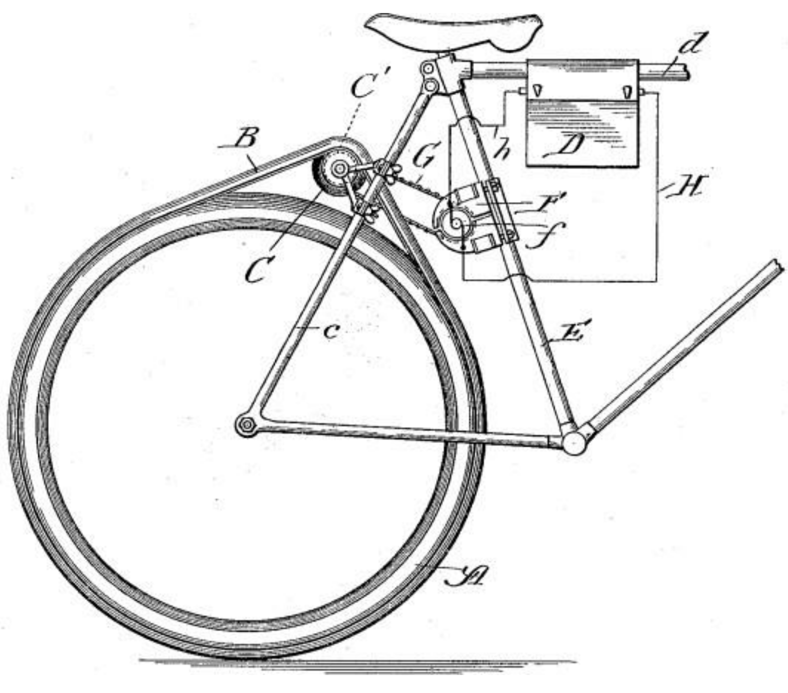


Fig 2.5 Driving Belt

1969 G. A. Wood Jr (4 Frictional HP Motor)

ELECTRIC DRIVE FOR BICYCLES Filed June 13, 1967 United States Patent 3,431,994 ELECTRIC DRIVE FOR BICYCLES Garfield A. Wood, Jr., 4565 Saba] Palm Road, Bay Point, Miami, Fla. 33137 Filed June 13, 1967, Ser. No. 645,703 US. Cl. 18031 12 Claims Int. Cl. B62k 11/10; B62d 3/00, 6/02 ABSTRACT OF THE DISCLOSURE The specification and drawings disclose an electrically operated bicycle drive. The drive assembly generally includes a friction drive wheel adapted to frictionally engage a tire of the bicycle to drive the bicycle. The friction drive wheel is rotated by a plurality of small electric motors connected by a gear train to a gear on the friction drive wheel. The drive assembly is clamped over either the front or rear wheel of the bicycle by a clamp which engages either the front or rear forks of the bicycle. The friction drive wheel is spring biased against the tire in its driving position to minimize slippage. Background of the invention The present invention relates to a drive assembly for propelling bicycles, and more particularly to an electrically operated bicycle drive assembly. Various types of motorized bicycles in which the bicycle is propelled by a motor-driven friction wheel engaged with a tire of the bicycle are well known in the art as represented by US. Patents 2,350,791, 2,409,887, 3,056,460 and 3,225,854. However, in the devices described by the aforesaid patents the motors are of the internal combustion type. These motors are quite heavy and bulky in relation to the amount of power they develop. Additionally, they generate considerable noise and often subject the operator of the vehicle to toxic exhaust fumes. With the current emphasis on the control of air pollution and on the use of motors which do not release toxic vapors, there is a need for a self-propelled bicycle which does not release toxic exhaust fumes. Summary of the invention It is accordingly one of the objects of the present invention to provide a bicycle drive assembly which is powered by electric motors. It is a more specific object of the present invention to provide a bicycle drive assembly which is powered by a plurality of su-bfractional horsepower electric motors of the type used on many small toys. It is a further object of the present invention to provide a bicycle drive assembly having a plurality of electric motors which propel the bicycle by the frictional engagement of a drive wheel with a tire of the bicycle.

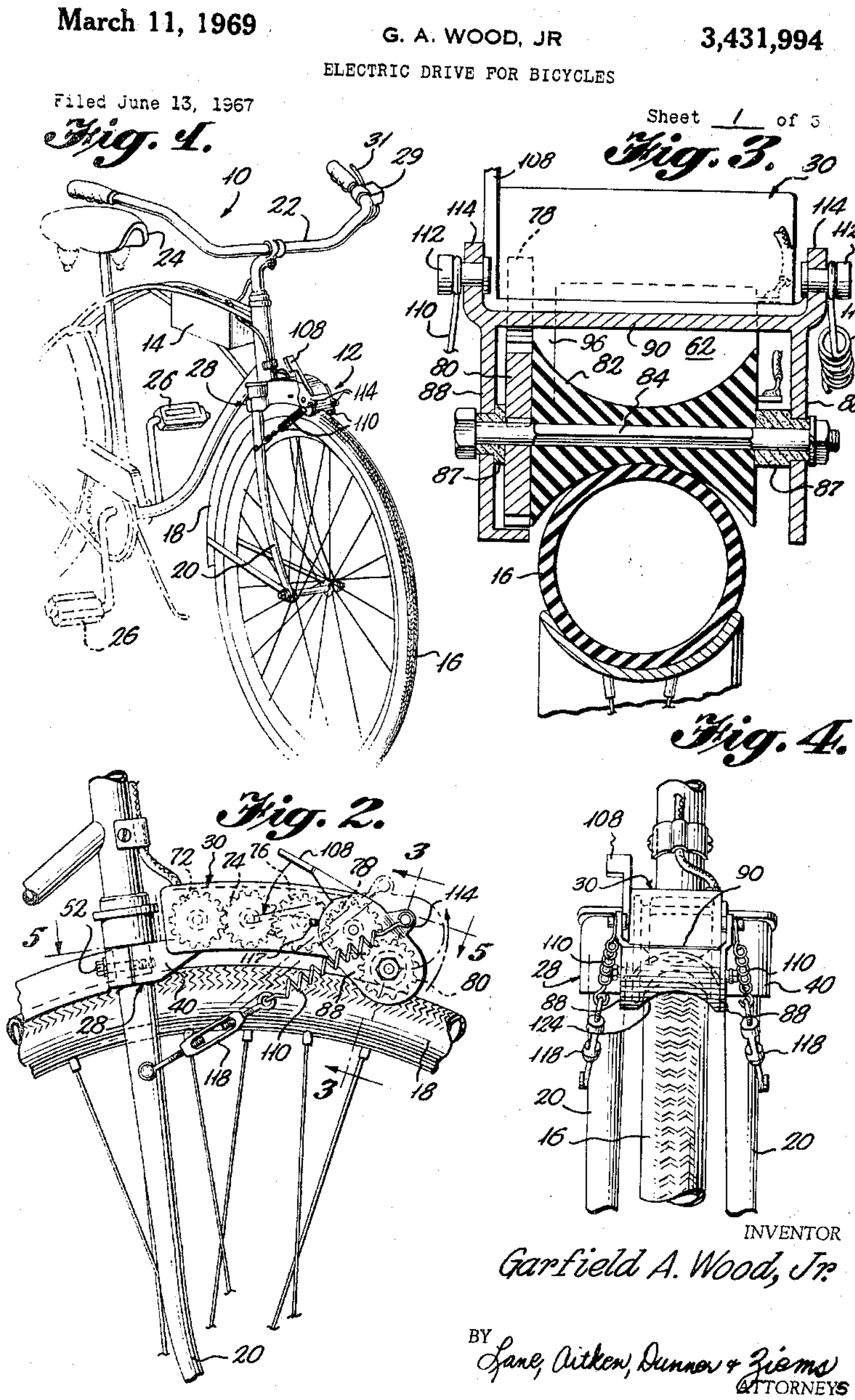


Fig 2.6 4 Frictional hp motor

CHAPTER 3
SYSTEM DEVOLOPMENT

Introduction

The detailed literature survey has been carried out in previous chapter. In this section of system development, the block diagram of proposed system, and each of component are explain in details in this system development, of our "Hybrid E-Bicycle"

Proposed System and Block Diagram:

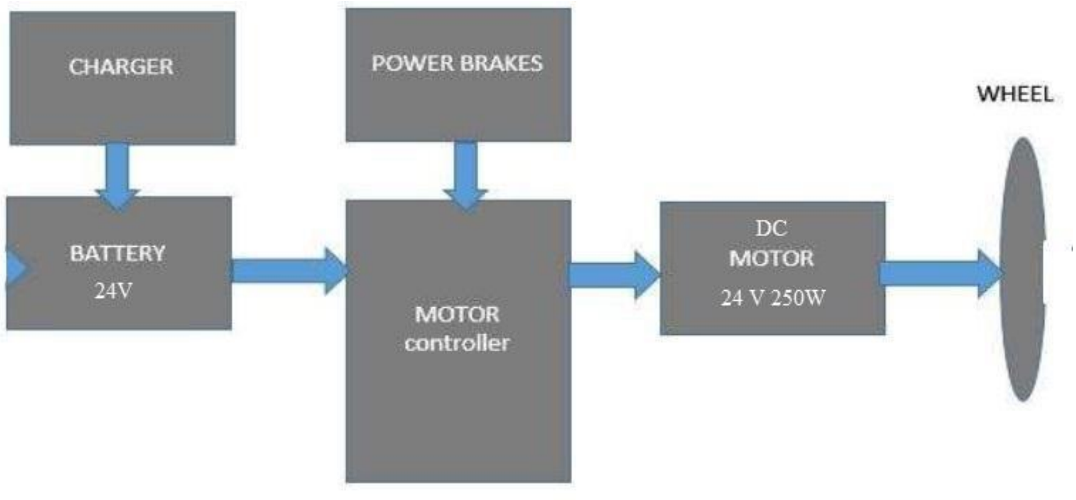


Fig3.2:Block diagram of "Hybrid E-Bicycle"s

Block diagram consist a different parts of this "Hybrid E-Bicycle" project as shows in above fig.

Principle of operation:

Motors is a device that converts electrical energy into mechanical energy. The principle of electric bikes motor is to generate the rotating magnetic field by using the electrified coil (that is, the stator winding) and act on the rotor squirrel-cage closed aluminum frame to form the magneto electric rotating torque. The motor is divided into DC motor and AC motor according to the power supply. Most of the motors in the power system are AC motors. Can be synchronous motor or asynchronous motor (motor stator magnetic speed and rotor rotation speed do not maintain synchronous speed. The motor is mainly composed of the stator and the rotor. The direction of the force motion of the electric wire in the magnetic field is related to the direction of the current and the direction of the magnetic sense (the direction of the magnetic field). The working principle of the motor is the effect of magnetic field on the current force, which makes the motor rotate. Electric bikes motor power is different, such as the general assembly of 12AH battery four blocks of motor power is 350 W, this refers to the internal gear of the high speed motor. In the case of a brushless toothless motor, the actual power is 250 W.

Circuit Diagram:

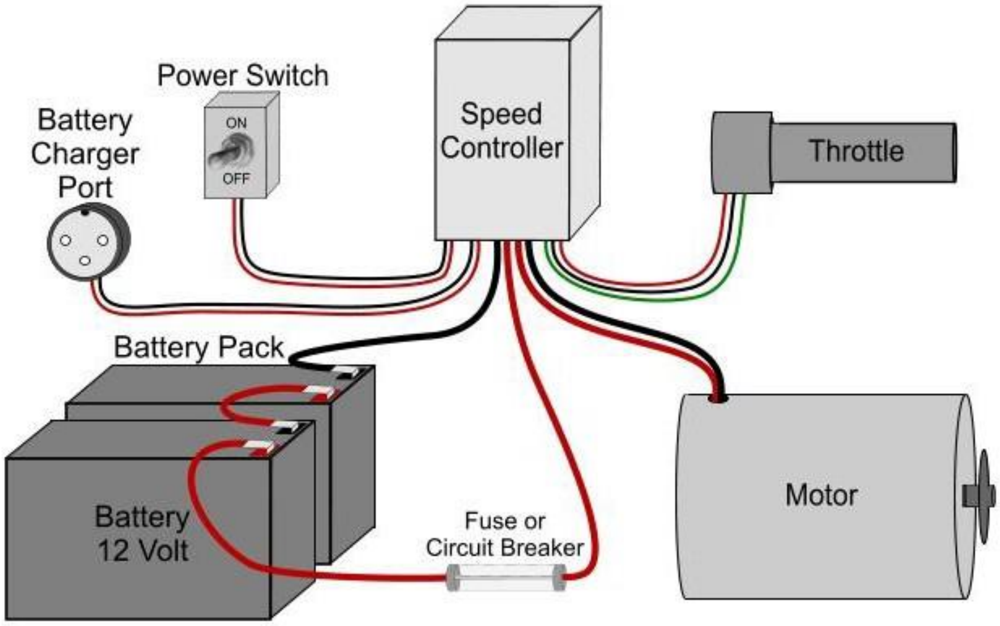


Fig3.3: Circuit Diagram of "Hybrid E-Bicycle"

Here is a basic wiring schematic for an electric scooter, bike, or go kart which indicates how to hook up all of the components, The speed controllers wiring directions will precisely indicate which wires to connect to which parts and components. Wiring an electric scooter, bike, or go kart is as simple as it looks in the drawing. Its just a matter of wiring a few parts and components together to the speed controller.

In this diagram the components we are used is the basic components of hybrid e bicycle like controller, 24V DC motor, padal assist, gear, high quality LED lamp, 12V 2set battery, battery charger, and the throttle and some basic equipments we are used in this project.

Hardware Requirement:

A traditional bicycle is a two-wheel vehicle that is propelled by the rider who delivers muscle power through pedals that rotate one of the two wheels. The rider steers the front wheel to create a force that returns and maintains the vehicle center of gravity into a stable zone whenever necessary, thus keeping the bicycle upright. An electric bicycle carries batteries that deliver electric power to a motor that is coupled to either wheel. In most electric bicycles the rider can chose to use muscle power to deliver all, part, or none of the propulsion power required to maintain an adopted travel speed. Some models even sense pedal pressure and command the motor to deliver more power whenever the rider pedals harder.

A controller for an electric bicycle must deliver power that varies from zero to the rated peak of the propulsion-motor, at motor speeds corresponding to bicycle speeds from zero to 48 km per hour (30 mph). With DC propulsion motors, power can be controlled with pulse-width modulated (PWM) transistors. AC motors need variable frequency. Hardware requirements for design of an electric-bicycle control are postulated and basic blocks along with their usage are shown.

An electric bicycle has a conventional bicycle frame, pedals, cranks, chain, and freewheel assembly. Electric propulsion replaces or supplements muscle power. This adds to the bicycle an electric motor, gear reducer, battery, and power control. The following defines the requirements of an electric bicycle:

1) The complete bicycle must have the lowest practical mass. All mass must be hauled over hills with energy supplied by the battery. Lower mass gives more range between recharging of the battery.

2) Bicycle stability is another important requirement. Total mass need not affect stability, but the placement of mass is important.

Sr.	COMPONENT	MASS IN KG
1	Bicycle assembly	10
2	Motor and gear	6
3	Power control	1
4	Battery	6
5	Cyclist	80
6	Total weight	106

Table 3.1 : Range of Mass

Components :

In this project we are using different types of components are following :

1) 36V 250Watt BLDC Hub Motor
2) Power Controller
3) 36V Battery
4) Chain Drive
5) Braking System
6) Sprocket
7) Thumb Throttle
8) Battery Charger
9) Non Geared Cycle

HUB MOTOR

Fig 3.4.1:Hub Motor

An electric motor converts electrical energy into mechanical energy. A 250Watt 36V High power DC Hub Motor used in electric bicycle. A BLDC motor is an internally commutated electric motor designed to be run from a direct current power source.

Specifications

Wheel Diameter - 20/26/27.5/28 and 26'*4 inch(Fat Tyre)

Construction - Gear drive : BLDC hub motor with inbuilt planetary box

Rated Voltage – 36V

RPM – 250:290

Rated Power – 250 Watt

Max Torque – 32 N.m

Efficiency – 83.5%

Weight (Kg) – 3

Noise Grade (dB) - <55

Operating Temperature - -20 to +45

PRINCIPLE OF OPERATION:

A electric bike hub motor is a device that converts electrical energy into mechanical energy. It produces a rotating magnetic field by using an electric coil (the stator winding) and acts on the rotor squirrel cage type closed aluminum frame to form a magneto electric rotating torque. The electric bike hub motor for sale is divided into DC motor and AC motor according to the power supply. Most of the motors in the power system are AC motors. Can be synchronous motor or asynchronous motor.

The electric bike hub motor is mainly composed of stator and rotor. The direction of force movement of electric conductor in the magnetic field is related to the direction of current and magnetic inductance (magnetic field direction). The working principle of the motor is the effect of magnetic field on the current force, which makes the motor rotate. A motor is a rotating electric machine that transforms electrical energy into mechanical energy. It consists mainly of an electromagnet winding or a distributed stator winding used to generate a magnetic field and a rotating armature or rotor. Under the action of the rotating magnetic field of the stator winding, it rotates in the armature squirrel cage aluminum frame by the current passing through and by the action of the magnetic field. Some of these machines can be used as motors or generators. It's a machine that converts electrical energy into mechanical energy. The work part of a motor is usually rotated, which is called a rotor motor. The construction of a simple BLDC motor is shown in Figure. All BLDC motors are made of the same basic components: a stator, rotor, and a commutator.

Stator:

The stator generates a stationary magnetic field that surrounds the rotor. This field is generated by either permanent magnets or electromagnetic windings. The different types of BLDC motors are distinguished by the construction of the stator or the way the electromagnetic windings are connected to the power source.

Rotor:

The rotor, also called the armature, is made up of one or more windings. When these windings are energized they produce a magnetic field. The magnetic poles of this rotor field will be attracted to the opposite poles generated by the stator, causing the rotor to turn. As the motor turns, the windings are constantly being energized in a different sequence so that the magnetic poles generated by the rotor do not overrun the poles generated in the stator. This switching of the field in the rotor windings is called commutation.

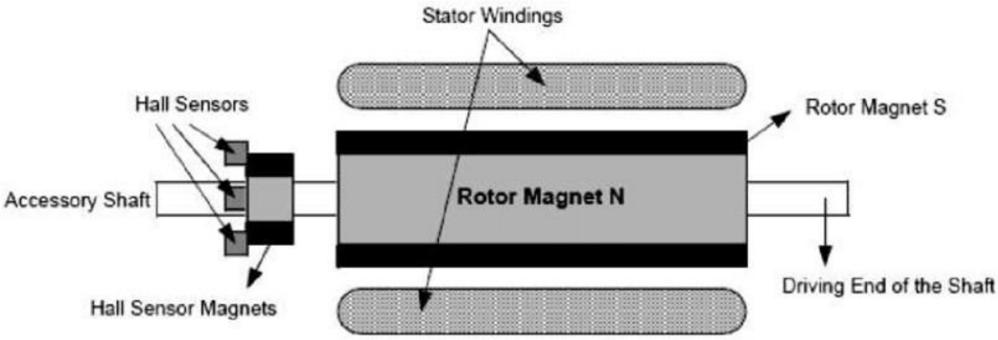


Fig 3.4.1.1 BLDC Motor Mechanical Structure

Unlike a brushed DC motor, BLDC motor can be controlled electronically. To rotate the BLDC motor, the stator windings must be energized in a special sequence. The rotor position must be known in order to understand which winding will be energized next. The rotor position is sensed using Hall Effect sensors that are embedded in the stator. A sensorless approach can also be used. Most BLDC motors have three Hall sensors embedded in the stator on the non driving end of the motor.

Whenever the rotor magnetic poles pass near the Hall sensors, they generate a high or low signal, which indicates that N or S pole is passing near the sensors. Based on the combination of these Hall Sensor signals, the exact sequence of commutation can be determined. Sensorless applications are becoming more popular as this simplifies motor construction and wiring. More advanced software is needed but this is easily achievable.

Because of the increasing popularity of ebikes, motors designed specifically for ebike applications are now commercially available. These motors vary a great deal in how they are mounted to a bicycle and in how the power is applied to them. As mentioned above, both sensored and sensorless types are available.

Advantages:

It depends whether you're talking about an electric bicycle or an electric car. Adding a hub motor and batteries to a bicycle is a mixture of pro and con: you increase the bicycle's weight quite considerably but, in return, you get a pleasant and effortless ride whenever you don't feel like pedaling. Where electric cars are concerned, the benefits are more obvious. The weight of the metal in a typical car (including the engine, gearbox, and chassis) is perhaps 10 times the weight of its occupants, which is one reason why cars are so very inefficient. Swap the heavy engine and gearbox for hub motors and batteries and you have a lighter car that uses energy far more efficiently. Getting rid of the engine compartment also frees up a huge amount of space for passengers and their luggage—you can just stow the batteries behind the back seat!

Calculations for motor selection :

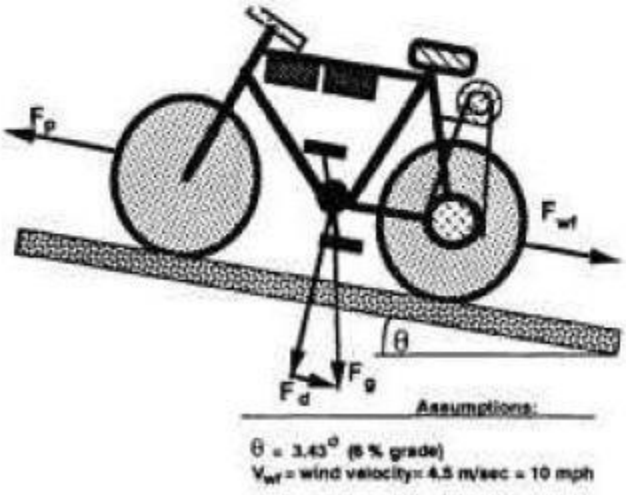


Fig 3.4.1.2 Range of mass

Fig shows the required power to develop the necessary wheel torque for the indicated travel conditions:

Fwf = windage and friction drag

Fd = downhill force from gravity

FP = propulsion force = Fwf + Fd

Vb = bicycle speed = 20 km/hr

Fd = m sin **x**

Pd = F × Vb = 28 × 8.33 m/s = 229.07W

Headwind speed = 25 km/hr, adds 30-W power to propel

Hence the power required by the motor to propel the bicycle and rider is 250 W.

TYPE	ADVANTAGES	DISADVANTAGES	TYPICAL APPLICATION	Typical Drive
Stepper DC	Precision positioning Stepper DC High holding torque	Slow speed Requires a controller	Positioning in printers and floppy drives	Multiphase DC
Brushless DC electric motor	Long lifespan Low maintenance High efficiency	High initial cost Requires a controller	Hard drives CD/DVD players Electric vehicles	Multiphase DC
Brushed DC electric motor	Low initial cost Simple speed control	High maintenance (brushes) Limited lifespan	Treadmill exercisers Automotive starters Toys	Direct (PWM)

Table No.3.2 Selection of Motor

CONTROLLER

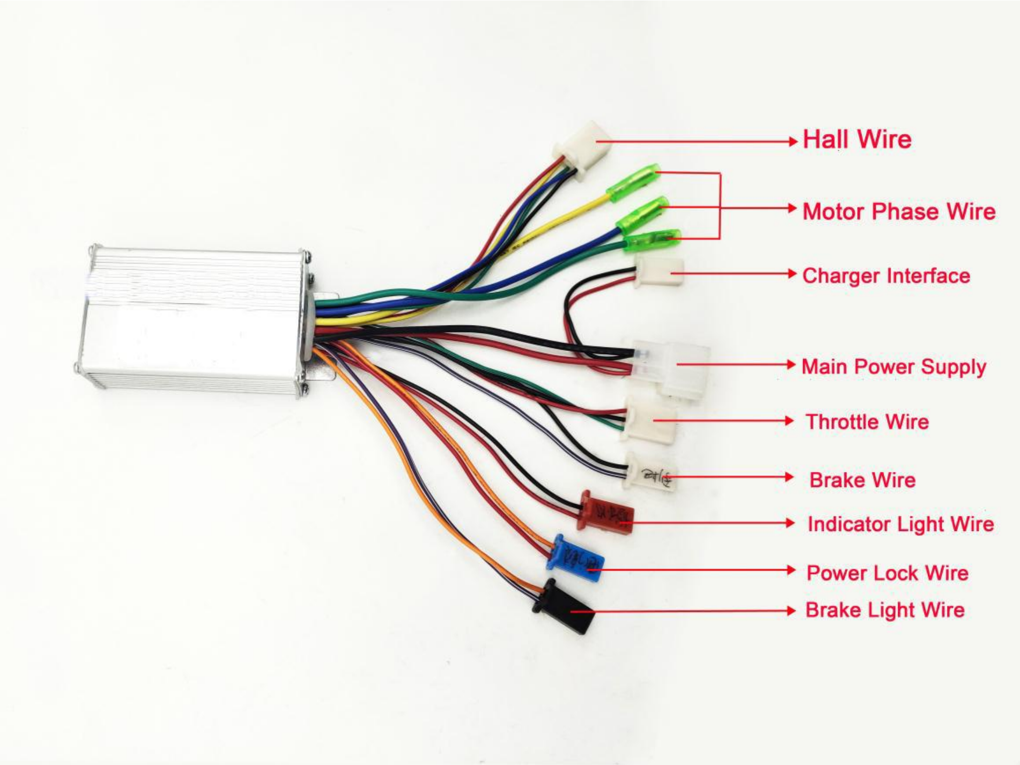
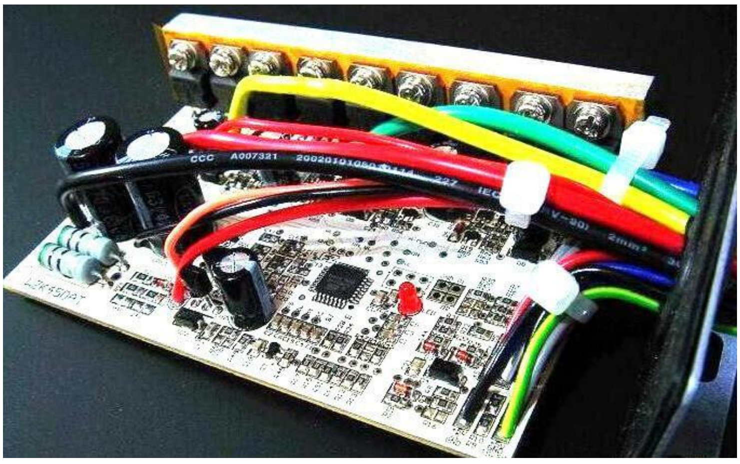


Fig 3.4.2 Controller

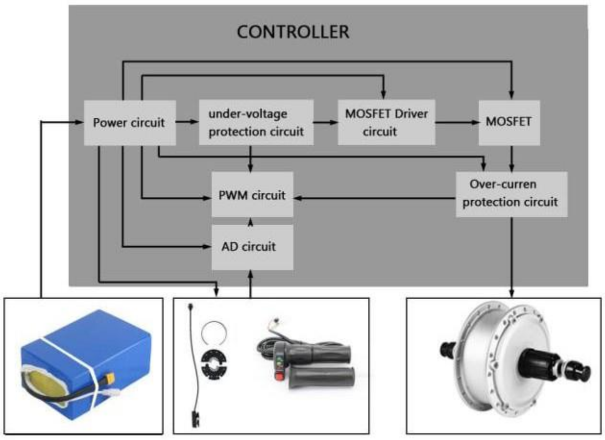
The electric bike controller is one of the main parts of an electric bike, it is the brain of the e-bike, controlling the motor's speed, start, stop. It is connected to all the other electronic parts such as the battery, motor, and the throttle(accelerator), display(speedometer), PAS or other speed sensors if exist. A controller is composed of main chips (microcontrollers) and peripheral components (resistors, sensors, MOSFET, etc). Generally, there are PWM generator circuit, AD circuit, power circuit, power device driver circuit, signal acquisition and processing circuit, over-current and under-voltage protection circuit inside the controller.



How does the electric bike controller work?

After connecting the battery, the controller supplies the working voltage to the external device through the power circuit, such as the switch +5V, headlight + 5V, etc. The PWM outputs a corresponding pulse waveform to the MOSFET drive circuit based on the input of the throttle or PAS. The MOSFET drive circuit controls the turn-on and turn-off of the MOSFET circuit to control the motor speed.

The under-voltage circuit is to protect the battery from discharging when the voltage is lower than the controller set value, at this time the PWM circuit stops the output. The over-current protection circuit limits the working of the controller, battery, motor at an over higher current.



the function of an electric bike controller :

The core function of an electric bike controller is to take all the inputs from all the electric components (throttle, speed sensor, display, battery, motor, etc.) and then determine what should be signaled in return to them (motor, battery, display). Other multiple protection functions of the controller will be different from the controller's design. Following are some basic protection functions.

1) Over-voltage protection. The controller monitors the battery voltage and shut down the motor when the battery voltage is too high. This protects the battery from over-charge.

2) Low-voltage protection. The controller monitors the battery voltage and shut down the motor when the battery voltage is too low. This protects the battery from over-discharge.

3) Over-temperature protection. The controller monitors the temperature of the FET(field-effect transistor) and shut down the motor if they become too hot. This protects the FET power transistors.

4) Over-current protection. reduce the current to the motor if too much current is being supplied. this protects both the motor and the FET power transistors.

5) Brake protection. The motor shut down when braking even though other signals taken by the controller at the same time. For example, if the user applies brake and throttle at the same time, the brake function wins.

How to choose the electric bike controller?

The controller should be chosen to fit the other parts- motor, battery, display, etc. The following factors would be considered.

1. The controller driving type- is it a sine wave or square wave controller?

Sine wave controller advantage
(1) lower noise.

(2) Higher motor efficiency when climbing or with a heavy load.

(3) Sine Wave controllers have a much smoother and more predictable control of all the operation.

Sine wave controller disadvantage:

(1) Higher price.

(2) Works with the matched motors only.

(3) Higher power consumption.

Square wave controller advantage:

(1) Lower price

(2) Works with different motors

(3) Higher efficiency at sudden accelerate or brake

(4) Higher utilization of the power voltage

Square wave controller disadvantage:

(1) Bigger noise.

(2) The control is not linear, not smooth, and punched sometimes.

(3) Lower motor efficiency when climbing or with a heavy load.

Generally, if a motor has hall sensors, the controller should be hall-sensor or dual mode. Hall sensor in the motor will sense the motor rotation, and the controller will output the corresponding voltage to the motor according to the sensor signals. It is more stable, with lower power consumption and bigger start torque. When the motor hall sensor damaged, the hall-sensor controller may prompt error and stop work while a dual mode controller works well.

The controller voltage should match the voltage of the motor and the battery

The controller current should be smaller than the battery output current. Generally, the max current is 18A for a 6-MOSFET controller, 25A for a 9-MOSFET controller, 35A for a 12-MOSFET controller, 40A for a 15- MOSFET controller, 50A for a 18- MOSFET controller.

How to connect the electric bike controller?

The wire types and wire terminal(connector) of the e-bike controller could be different in the different controller design. You need the electric bike controller wiring diagram to ensure the right wiring connections. Most e-bike controller will have these wires motor, battery, brakes, throttle/ accelerator or PAS Pedal Assist System (some controllers have both types of wires, some have one of them). Some more wires are found in the advanced controllers, such as Display or speedometer, Three speeds, Reverse, LED light, etc. Here is one KT controller wiring diagram.

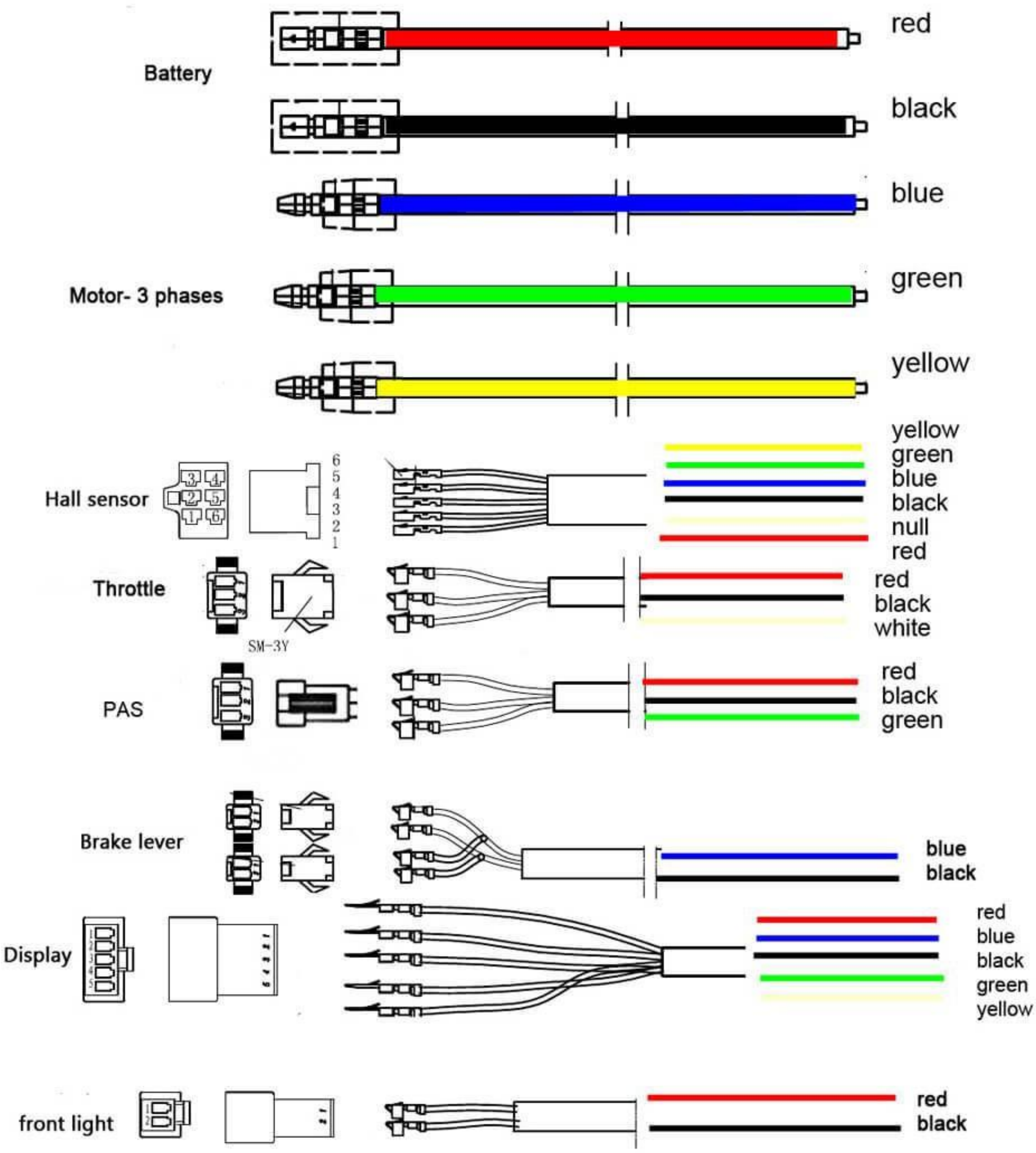


Fig : Connection of controller

36V Battery :

Fig 3.4.3 Li-Battery

The fig shows A lithium-ion battery or Li-ion battery is a type of rechargeable battery. In this project we are using 36V 10Ah Lithium-ion batteries are commonly used for portable electronics and electric vehicles and are growing in popularity for military and aerospace applications. A prototype Li-ion battery was developed by Akira Yoshino in 1985, based on earlier research by John Goodenough, M. Stanley Whittingham, Rachid Yazami and Koichi Mizushima during the 1970s–1980s, and then a commercial Li-ion battery was developed by a Sony and Asahi Kasei team led by Yoshio Nishi in 1991.

Chemistry, performance, cost and safety characteristics vary across types of lithium-ion batteries. Handheld electronics mostly use lithium polymer batteries (with a polymer gel as electrolyte), a lithium cobalt oxide ($LiCoO_2$) cathode material, and a graphite anode, which together offer a high energy density. Lithium iron phosphate ($LiFePO_4$), lithium manganese oxide ($LiMn_2O_4$ spinel, or Li_2MnO_3-based lithium rich layered materials (LMR-NMC)), and lithium nickel manganese cobalt oxide ($LiNiMnCoO_2$ or NMC) may offer longer lives and may have better rate capability. Such batteries are widely used for electric tools, medical equipment, and other roles. NMC and its derivatives are widely used in electric vehicles.

You should typically expect a battery to last between 2 and 4 years if it is well maintained. (A lithium battery will slowly lose its capacity over time, even if it's not used.)

All lithium-ion batteries work in broadly the same way. When the battery is charging up, the lithium-cobalt oxide, positive electrode gives up some of its lithium ions, which move through the electrolyte to the negative, graphite electrode and remain there. The battery takes in and stores energy during this process

Drawback : Despite its overall advantages, lithium-ion has its drawbacks. It is fragile and requires a protection circuit to maintain safe operation. Built into each pack, the protection circuit limits the peak voltage of each cell during charge and prevents the cell voltage from dropping too low on discharge.

Volts: Used to describe how fast electrons move, more voltage = more speed

Amps: How wide the road is, more lanes, more cars can pass at the same time side by side

Watts: The combination of Volts and Amps (Volts X Amps = Watts)

Amp Hours: Should always be listed, typically 10 to 20 Amp Hours (abbreviated " Ah ") a measure of how many fixed number of Amps a battery can sustain for 1 hour.. (C rate). Or, double the amps for half the time.. Or half the amps for two hours.etc.

Watt Hours: This is a far more accurate way to know how much usable energy is in a given battery pack (abbreviated Wh) when available, this is the number to look for! Also, you can translate it into how many watts, continuous, for 1 hour! A 500wh battery can deliver 500 watts for 1 hour or 1000w for 30 minutes. or 250w for 2 hours .. etc.. Most ebikes do not use power at an exact level, continuously, so this does not directly translate into ride time, but you can quickly see how a larger battery with more energy (capacity) can deliver lower power levels for longer periods of time, and go further on a charge.

Battery energy (Watt Hours)	Load	Run Time (hours)
500 wh	250w	2 hours
500 wh	500w	1 hour
500 wh	1000w	30 minutes

Table No.3.4.4

Battery Selection:

See the following equations to calculate the range from amperage and voltage:

Ah (Amp hours) × V (volts) = Wh (Watt hours)

Select a 36-V, 10-AH battery with 360 Wh.

P (power) = Work / t (time)

P × t = Work = Force × distance

Force = mass × acceleration

Distance = Wh / Force

Chain Drive :

Fig 3.4.4 Chain Drive

Chain drive is a way of transmitting mechanical power from one place to another. It is often used to convey power to the wheels of a vehicle, particularly bicycles and motorcycles. It is also used in a wide variety of machines besides vehicles.

Most often, the power is conveyed by a roller chain, known as the drive chain or transmission chain,[1] passing over a sprocket gear, with the teeth of the gear meshing with the holes in the links of the chain. The gear is turned, and this pulls the chain putting mechanical force into the system. Another type of drive chain is the Morse chain, invented by the Morse Chain Company of Ithaca, New York, United States. This has inverted teeth.

Sometimes the power is output by simply rotating the chain, which can be used to lift or drag objects. In other situations, a second gear is placed and the power is recovered by attaching shafts or hubs to this gear. Though drive chains are often simple oval loops, they can also go around corners by placing more than two gears along the chain; gears that do not put power into the system or transmit it out are generally known as idler-wheels. By varying the diameter of the input and output gears with respect to each other, the gear ratio can be altered. For example, when the bicycle pedals' gear rotate once, it causes the gear that drives the wheels to rotate more than one revolution. Duplex chains are another type of chain which are essentially two chains joined side by side which allow for more power and torque to be transmitted.

Braking System

Fig No 3.4.5 Brakes

Most bicycle brake systems consist of three main components: a mechanism for the rider to apply the brakes, such as brake levers or pedals; a mechanism for transmitting that signal, such as Bowden cables, hydraulic hoses, rods, or the bicycle chain; and the brake mechanism itself, a caliper or drum, to press two or more surfaces together in order to convert, via friction, kinetic energy of the bike and rider into thermal energy to be dissipated.For the braking system it is convenient to use braking system used in band brake system which consist spring loaded friction shoe mechanism, which driven with the help of hand driven.

Braking Technique:

The motion dynamics of a bicycle will cause a transfer of weight to the front wheel during braking, improving the traction on the front wheel. If the front brake is used too hard, momentum may cause the rider and bike to pitch forward - a type of crash sometimes called an "endo." Light use of the rear brake causes a light skid as the bicycle approaches the limit where pitchover will occur, a signal to reduce force on the front brake. On a low-traction surface or when turning, the front wheel will skid, the bicycle cannot be balanced and will fall to the side instead

Sprocket

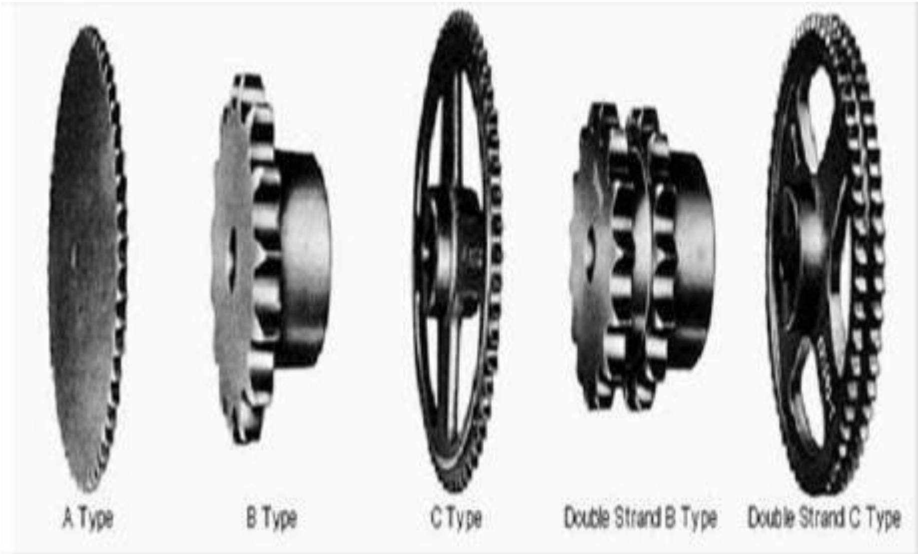


Fig No. 3.4.6 Sprocket

The chain with engaging with the sprocket converts rotational power into rotary power and vice versa. The sprocket which looks like a gear may differ in three aspects:

1) Sprockets have many engaging teeth but gears have only one or two.

2) The teeth of a gear touch and slip against each other but there is basically no slip page in case of sprocket.

3) The shape of the teeth are different in gears and sprockets

Thumb Throttle

Fig No. 3.4.7 Throttle

A throttle was needed to provide a user interface to the mtor. The throttle needed to be rugged and bike mountable. This throttle uses a hall effect sensor, instead of the variable resistor sometimes found in electric throttles.

The thumb throttle on the right hand handlebar is available to the rider at any time the bike is switched on. It over rides the pedal assist giving full power at a moments notice. This is useful for hill starts, in heavy traffic and when getting away from traffic lights. The rider can also have a rest from pedalling. Due to a change in the law on 6th April 2015, the throttle will run the motor up to 5KPH(3MPH) when the pedals are not being turned, and up to 25KPH (15MPH) when the pedals are rotating. However, any bike sold before the change of the law will run up to 25KPH (15MPH) on throttle at all times.

Battery Charger

Fig No. 3.4.8 Charger

The fig shows the Li Battery charger the rating of this charger is 36V for battery charging simply it is a AC to DC Converter runs on 230V AC supply.

Our Lithium Ion Batteries have a built in battery protection system that allows them to be charged with a standard charger. In some cases if your battery charger does not reach 14.4V - 14.6V during charging it may not fully top off the Smart Battery. In this case we would recommend you purchase a Smart Battery Charger.

Lithium batteries require a Constant current/Constant voltage (CC/CV) charge type with simple Bulk, Absorption, Float stages. Many lead acid chargers have desulphation and equalisation stages built in, which will pulse high voltages of 15.3-15.8V into the battery.

Non geared Bicycle

Fig No. 3.4.9 Cycle

In this project we are using non geared bicycle for better mechanism and high efficiency we are mounting hub dc motor in back side tire of the cycle .

A bicycle, also called a bike or cycle, is a human-powered or motor-powered, pedal-driven, single-track vehicle, having two wheels attached to a frame, one behind the other. A bicycle rider is called a cyclist, or bicyclist.

Bicycles were introduced in the 19th century in Europe, and by the early 21st century, more than 1 billion were in existence at a given time.[1][2][3] These numbers far exceed the number of cars, both in total and ranked by the number of individual models produced.[4][5][6] They are the principal means of transportation in many regions. They also provide a popular form of recreation, and have been adapted for use as children's toys, general fitness, military and police applications, courier services, bicycle racing, and bicycle stunts.

Advantages:

- This allows for much faster movement in congested downtown areas.
- Electric bicycles also allow the rider to pedal and get exercise in time they normally spend commuting.
- No fuel required.
- Health benefits.
- Pollution free ride.
- Less parking space required .
- No age limit to ride the e bike.
- Normal pedalling is possible when not on power assist mode.
- No noise - no vibration - no smog - no smog checks.
- No maintenance so coat is zero.

Disadvantages:

- E-bikes are overall pricey;
- Battery has a rather short lifespan;
- Battery charge time is long;
- Riding range remains low;
- E-bikes are considerably heavier;
- Maintenance and repairs are costly;
- E-bikes tend to have low resale value;

Application:

- Short city rides
- In cycle parks.
- Daily life uses.
- It is use full for school and collage students for daily purpose.

Cost of components

Sr.	Component Name	Quantity	Price in INR
1)	Hub Motor	1	5900
2)	Battery	1	4900
3)	Battery charger	1	1200
4)	Controller	1	700
5)	LED Lamp	1	100
6)	kit	1	1500
7)	Cycle	1	2000
		TOTAL	**16300/-**

Table no. 3.8 Cost of components

CHAPTER 4
PERFORMANCE ANALYSIS

4.1 Introduction:

In order to verify the performance of system development considering the block diagram of proposed system i.e. “Hybrid E-bicycle” the work is done in order to following all the kind of calculations and steps. The battery supply is given to the motor through controller and it is working perfectly as we expects.

Fig: ***Actual image of the project***

CHAPTER 5

CONCLUSIONS AND FUTURE SCOPE

In this dissertation report the implementation of “Hybrid E-Bicycle” it conclude the its possible to make pollution free vehicle runs on electric motor and consume minimum energy and also having low maintenance.

Conclusions:

That the Hybrid Electric Bicycle Project was a tremendous success can be seen in the level of interest it generated in cyclists and participating organizations. Moreover, the sustained media attention received throughout the evaluation project was an indication of the enthusiasm felt for this new mode of transportation.

Because the e-bikes were tested in actual-use situations by people of all ages in various cities, the study and its findings are widely applicable.

This project highlights the hybrid e-bicycle it is the replacement of conventional fuel vehicle and helps environment to CO2 free (emission free) , it gives maximum efficiency also have 0 maintenance.

Future Scope of Work:

E-bikes admittedly have little appeal for competitive cyclists or mountain bike enthusiasts. However, they are a feasible mode of transportation for commuting to work or travelling short distances. During these tests, many people were attracted to the e-bikes, which rekindled their interest to travel by different means than a car. Some of them had given up on conventional bicycles because it was difficult to climb the steep hills on their route. Others were hesitant about riding bicycles because of weather conditions. The evaluation results and the excitement generated by this new vehicle suggest that a segment of the population would leave the car at home and commute to work by e-bike, at least in fine weather. Seniors and people with respiratory conditions, cardiovascular problems or muscular disabilities can rediscover the pleasures of cycling without having to expend a lot of physical effort.

It appears that a new market niche will open up for e-bikes without compromising the traditional bicycle market. As with conventional bicycles, the more varied the choice of e-bikes, the greater the number of consumers who will find a product that meets their needs.

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