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Design and fabrication of dual chargeable bicycle

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ABSTRACT

With the increase in fuel prices, pollution content in atmosphere and due to gradual end of the non renewable sources of energy we have to alter the source of our energy in our vehicles. Considering all these reasons we have to switch over to other sources of energy instead of using conventional sources such as petrol which in future will be going to extinct. One way to alter the energy source is to go for electric vehicles or e bikes. Electric driven vehicles uses battery as a source of energy which provide power to motor which in turn provide torque to wheels .The old design of electric bicycle was having only a single mode of charging, it was just capable to travel 15 km through battery and was not ergonomically good. The new design uses a low rpm alternator for charging the battery by keeping it in contact with front wheel .A Motor of 0.5hp provides torque to the rear wheel and the gear ratio is kept 5:2 .battery discharging time is approximately 2 hrs and charging time through alternator is 1 hour and the bicycle can attain a maximum speed of 15 km/hr. This work is more beneficial in hilly region and confined areas like college campus and schools, generating zero pollution, zero noise effect and no fuel consumption.

Keywords: Dual chargeable bicycle, EABs, EPBs, Battery, Alternator, Controllers

1. INTRODUCTION

1.1 Introduction

Bicycles are one of the most ubiquitous forms of transportation in the world. Most children remember their first bike; with it came the chance to explore their world with more freedom than ever before. As we grow, however, bicycling becomes more than just a childhood rite of passage. Wind in our hair and feet on the pedals, we have several good reasons to climb on and take a trip. Much of the world uses bicycles as a primary form of daily transportation. What would take several hours of travel on foot becomes faster and more efficient on two wheels. Some cyclists take trips across entire states or cross-country solely on a bicycle. Reaching speeds of 15 miles or 30 km an hour is achievable by even beginning cyclists, while more experienced riders can reach speeds equivalent to automobile travel. "Century riders" travel 100 miles or more within a typical day. Not to be constrained by simple transportation, bicycles (stationary and otherwise) have helped people become healthier by losing excess weight and improving cardiovascular fitness. The exercise benefits of cycling are well known. Using the largest muscles in the body, bicycling allows riders to reach aerobic heart rates that drive up metabolism, and give a good workout. With the relative newcomer in the bicycle world, mountain bikes, this form of transportation is taking us on rugged terrain once thought impassable by anything other than hiking boots or pack animals. Extreme sport enthusiasts have adapted the bicycle to perform gravity defying stunts, such as flips and mid air acrobatics, in a style known as BMX (Bicycle Motorcross). In short, bikes remain a popular way to get people between points A and B, whether those destinations are found on a map, from one state of health to another, or to explore the unknown. Bicycles have become an important part of the landscape. Most people understand the saying, "as easy as riding a bike." Or we understand that some dormant skill is easy to pick back up if it's "just like riding a bike." Likewise, many immediately think of bicycles when we make an allusion to "coasting", "picking up speed", or "going downhill".

1.2 Time Line in the History of Bicycle

1791 The first reported plank-with-two wheel on which the rider sat and propelled by thrusting feet on ground.
1817 Baron von Drais makes the front wheel steerable. Hobbyhorse is invented. Huge success as a novelty.
1839 Kirkpatric MacMillan of Scotland attaches treadle and cranks to the rear wheels to "invent' the first two-wheeled vehicle. Not well received at all. MacMillan is credited now to be the inventor of the bicycle.
1863 Pedals are added to the front wheel. The Bone-shaker is launched. Riding velocipedes soon becomes a fad.
1865 Radial (and torsion) spokes are introduced making bicycles lighter.
1869 Solid rubber tires are introduced in place of iron tires. The term "bicycle' is first used.
1870 Tangential spokes are used replacing radial and torsion spokes. No major change since then.
1872 Tall-ordinary or the Penny-Far thing makes appearance in England.
1888 JK Starley invents the Rover safety bicycle.
1889 Pneumatic tires are first used. The development of the basic bicycle is complete.
1896 Coaster brakes invented.
1899 Mile-a-minute barrier broken. Murphy completes a mile in 57, 75 second.
1903 Bicycle mechanics Orville and Wilbur Wright Invent' the aeroplane.
1965 Conservation movement and physical fitness buffs recognize the importance of bicycle and a bicycle boom begins.
1972 For the first time ever, bicycles outsell cars in United States of America.
1980 Disc wheels introduced in competition bicycles to reduce the aerodynamics drags due to individual spokes.
1985 Bicycle speed exceeds 150 miles per hour. John Howard sets the speed record at 152.28 mph.

1.3 Electric bicycles

Because of technological advances in storage cells and electric propulsion systems in recent years and in response to the growing demand for clean, efficient methods of transportation in our urban communities, electric bicycle development and marketing has surged ahead, especially in Asia and Europe.. E-bikes are not a replacement for conventional bicycles. However, they allow a greater number of people to travel on two-wheeled vehicles. In the future, they could evenbecome a means of locomotion that could substitute for the automobile, particularly inwarmer weather. E-bikes are for everybody, especially those who are not very active in sports, those with physical disabilities and seniors. They are also for veteran cyclists who commute to work on conventional bicycles to save money on fuel but wish to avoid arriving at the office covered in perspiration.Growth in e-bike use has skyrocketed since the electrically assisted bicycle (EAB) was introduced in 1997 by the Japanese firm Yamaha. This version of the e-bike has a small motor mounted on the back wheel to double the power generated by the cyclist. In 1998, the company scored a major commercial success by selling 500,000 units worldwide, making Japan the e-bike market leader. The European market is growing as well, with more than 100,000 units sold in 1999. However, there are no clear, standardized regulations for all European Economic Community countries.

1.4 Rationale of study

The reason to choose this project is to improve the overall performance of electric bicycle so that to increase its acceptance by the society over other vehicles.

1.5 Motivation for choosing the problem

Decrease in the natural resource of energy, increase in pollution rate causing ozone layer depletion by the emission of toxic gases by burning of fuels & global warming. To save the natural resources like petrol ,from being extinct and to control the pollution in environment we have to switch over to different mode of power resources as electricity.

1.46 Problem Statement

To improve the performance of electric bicycle by providing dual chargeable system

2. LITERATURE REVIEW

2.1 Development of different types of bicycles

2.1.1 The Walking Machine

In 1817 Baron von Drais invented a walking machine that would help him get around the royal gardens faster: two same-size in-line wheels, the front one steerable, mounted in a frame which you straddled. The device was propelled by pushing your feet against the ground, thus rolling yourself and the device forward in a sort of gliding walk. The machine became known as the Draisienne or hobby horse. It was made entirely of wood. This enjoyed a short lived popularity as a fad, not being practical for transportation in any other place than a well maintained pathway such as in a park or garden.

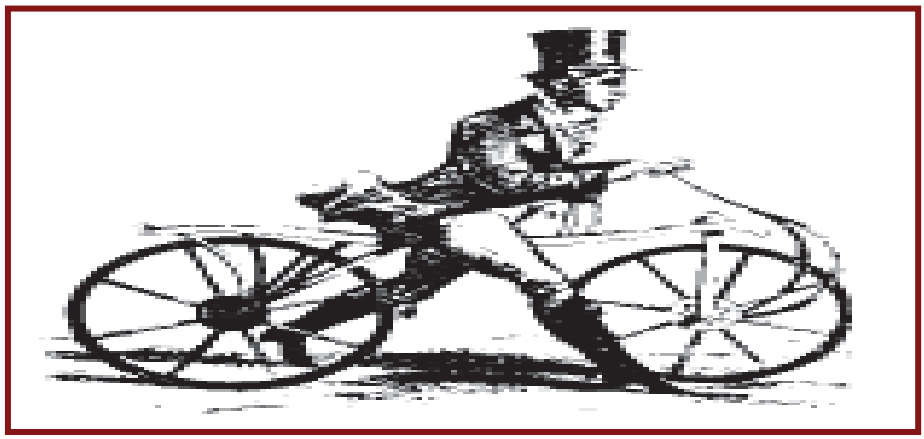

fig.2.1

2.1.2 The Velocipede or Boneshaker

The next appearance of a two-wheeled riding machine was in 1865, when pedals were applied directly to the front wheel. This machine was known as the velocipede ("fast foot"), but was popularly known as the bone shaker, since it was also made entirely of wood, then later with metal tires, and the combination of these with the cobblestone roads of the day made for an extremely uncomfortable ride. They also became a fad, and indoor riding academies, similar to roller rinks, could be found in large cities

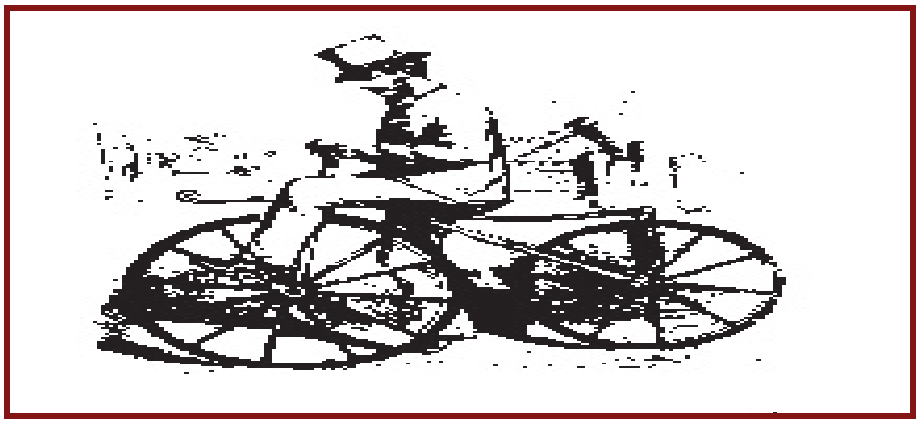

Fig 2.2

2.1.3 The High Wheel Bicycle

In 1870 the first all metal machine appeared. (Previous to this metallurgy was not advanced enough to provide metal which was strong enough to make small, light parts out of.) The pedals were still atttached directly to the front wheel with no freewheeling mechanism. Solid rubber tires and the long spokes of the large front wheel provided a much smoother ride than its predecessor. The front wheels became larger and larger as makers realized that the larger the wheel, the farther you could travel with one rotation of the pedals. You would purchase a wheel as large as your leg length would allow. This machine was the first one to be called a bicycle ("two wheel"). These bicycles enjoyed a great popularity among young men of means (they cost an average worker six month's pay), with the hey-day being the decade of the 1880s.

Fig 2.3

Because the rider sat so high above the center of gravity, if the front wheel was stopped by a stone or rut in the road, or the sudden emergence of a dog, the entire apparatus rotated forward on its front axle, and the rider, with his legs trapped under the handlebars, was dropped unceremoniously on his head. Thus the term "taking a header" came into being.

Fig2.4

2.1.4 The High Wheel Tricycle

While the men were risking their necks on the high wheels, ladies, confined to their long skirts and corsets, could take a spin around the park on an adult tricycle. These machines also afforded more dignity to gentlemen such as doctors and clergymen. Many mechanical innovations now associated with the automobile were originally invented for tricycles. Rack and pinion steering, the differential, and band brakes, to name a few!

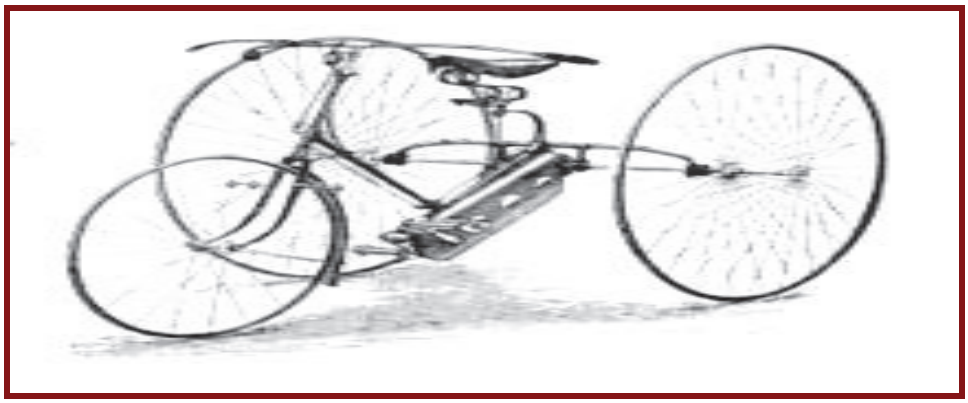

Fig2.5

2.1.5 The High Wheel Safety

Improvements to the design began to be seen, many with the small wheel in the front to eliminate the tipping-forward problem. One model was promoted by its manufacturer by being ridden down the front steps of the capitol building in Washington, DC. These designs became known as high-wheel safety bicycles. Since the older high-wheel designs

had been known simply as bicycles, they were now referred to as "ordinary bicycles" in comparison with the new-fangled designs, and then simply as "ordinaries."

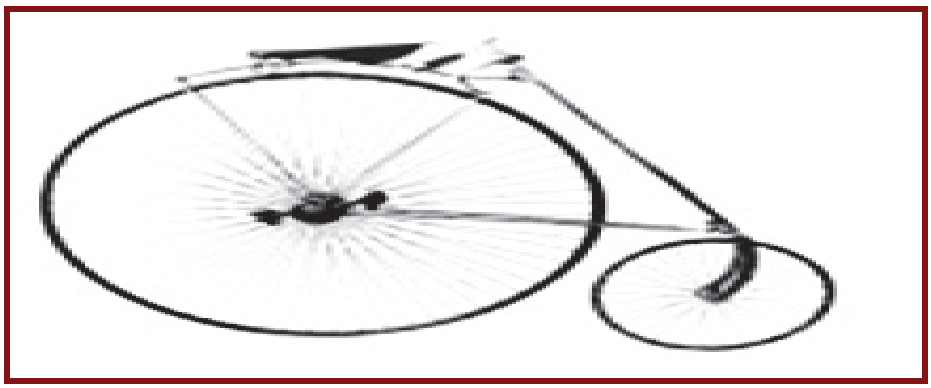

Fig2.6

2.1.6 The Hard-Tired Safety

The further improvement of metallurgy sparked the next innovation, or rather return to previous design. With metal that was now strong enough to make a fine chain and sprocket small and light enough for a human being to power, the next design was a return to the original configuration of two same-size wheels, only now, instead of just one wheel circumference for every pedal turn, you could, through the gear ratios, have a speed the same as the huge high-wheel. The bicycles still had the hard rubber tires, and in the absence of the long, shock-absorbing spokes, the ride they provided was much more uncomfortable than any of the high-wheel designs. Many of these bicycles of 100 years ago had front and/or rear suspensions. These designs competed with each other, your choice being the high-wheel's comfort or the safety's safety, but the next innovation tolled the death of the high-wheel design.

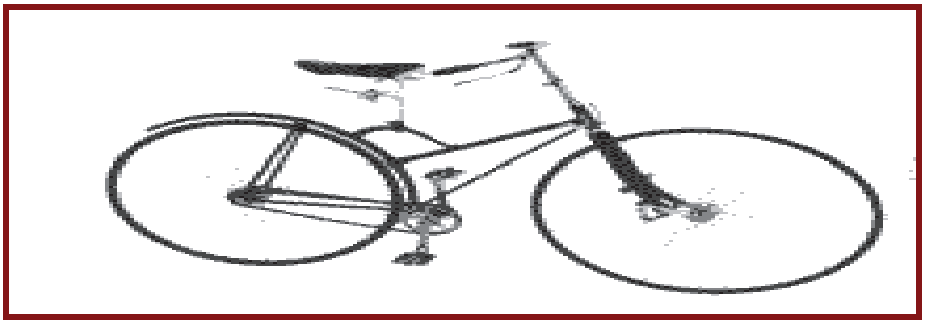

Fig2.7

2.1.7 The Pnuematic-Tired Safety

The pneumatic tire was first applied to the bicycle by an Irish veterinarian who was trying to give his young son a more comfortable ride on his tricycle. This inventive young doctor's name was Dunlop. Sound familiar? Now that comfort and safety could be had in the same package, and that package was getting cheaper as manufacturing methods improved, everyone clamoured to ride the bicycle. This 1898 Yale uses a shaft drive to dispense with the dirty. Chain. The bicycle was what made the Gay Ninties gay. It was a practical investment for the working man as transportation, and gave him a much greater flexibility for leisure. Ladies, heretofore consigned to riding the heavy adult size tricycles that were only practical for taking a turn around the park, now could ride a much more versatile machine and still keep their legs covered with long skirts. The bicycle craze killed the bustle and the corset, instituted "common-sense dressing" for women and increased their mobility considerably. In 1896 Susan B. Anthony said that "the bicycle has done more for the emancipation of women than anything else in the world." Bicycling was so popular in the 1880s and 1890s that cyclists formed the League of American Wheelman (still in existence and now called the League of American Bicyclists). The League lobbied for better roads, literally paving the road for the automobile..

Fig2.8

2.1.8 Electrically assisted bicycles (EABs)

An EAB works like a conventional bicycle with an electric motor added to assist the pedalling action. It is simple to use: press the start switch and the electric motor assists you when you apply pressure on the pedals. The motor increases the amount of power transmitted to the wheel. A special characteristic of the EAB is that it only runs when pedalled.

2.1.9 Electrically propelled bicycles (EPBs)

When the electric motor is not providing assistance, the EPB also works like a conventional bicycle. When the cyclist turns the function switch to "on" and presses the hand accelerator, the cyclist is propelled effortlessly by the electric motor without having to pedal. The propulsion of this type of e-bike is similar to that of a moped. EABs and EPBs are divided into several categories depending on the maximum power output ratio (1:1, 1:2, 1:3), the power output rating (average 250 W) and the speed limit at which the power assist cuts out.

Fig 2.9

3. DEFINITION AND CONCEPT

3.1 Motors and drive trains

There are many possible types of electric motorized bicycles with several technologies available, varying in cost and complexity; direct-drive and geared motor units are both used. An electric power-assist system may be added to almost any pedal cycle using chain drive, belt drive, hub motors or friction drive. BLDC hub motors are a common modern design with the motor built into the wheel hub itself and the stator fixed solidly to the axle and the magnets attached to and rotating with the wheel. The bicycle wheel hub is the motor. The power levels of motors used are influenced by available legal categories and are often, but not always limited to under 750 watts. On our bicycle we use 24 volt 5 Amp motor with 0 .5 Hp for better performance and low out put velocity (10-20 kmph).

3.2 Batteries

Electric bicycles use rechargeable batteries, electric motors and some form of control. Electric bicycles developed in Switzerland in the late 1980s for the Tour de Sol solar vehicle race came with solar charging stations but these were later fixed on roofs and connected so as to feed into the electric mains. The bicycles were then charged from the mains, as is common today. Battery systems in use include lead-acid, NiCd, NiMH and Li-ion batteries. Range is a key consideration with electric bikes, and is affected by factors such as motor efficiency, battery capacity, efficiency of the driving electronics, aerodynamics, hills and weight of the bike and rider. The range of an electric bike is usually stated as somewhere between 7 km (uphill on electric power only) to 70 km (minimum assistance) and is highly dependent on whether or not the bike is tested on flat roads or hills The energy costs of operating electric bicycles are small, but there can be considerable battery replacement costs. Riding an electric bicycle to work or to the store instead of taking a car has long term financial and health gains. From lots of given option we selected 2 lead acid batteries of 12 volt 5 amp because of its easy availability and low cost and connected in series to get an output of 24 volt.

3.3 Controllers

Control can be as simple as an on-off switch but more usually they are *power-on-demand*, where the motor is activated by a handlebar mounted throttle, and/or a *pedelec* (from **ped**al **elec**tric), also known as **electric assist**, where the electric motor is regulated by pedaling. These have a sensor to detect the pedaling speed, the pedaling force, or both. Brake activation is sometimes sensed to disable the motor as well. There are two distinct types of electric bike controllers designed to match either a brush or brushless motor. Brushless motors are becoming more common as the cost of controllers continues to decrease. The page on DC motor covers the differences between the two types. Electric bicycles require high initial torque and therefore models that use brushless motors typically have Hall sensor commutation for speed measurement. An electronic controller provides assistance as a function of the sensor inputs, the vehicle speed and the required force. The controllers generally provide potentiometer-adjustable motor speed, closed-loop speed control for precise speed regulation, protection logic for over-voltage, over-current and thermal protection. The controller uses pulse width modulation to regulate the power to the motor. Sometimes support is provided for regenerative braking but infrequent braking and the low mass of bicycles limits recovered energy. An implementation is described in an application note for a 200 W, 24 V Brushless DC (BLDC) motor. Brush motors are also used in electric bikes but are becoming less common due to their intrinsic lower efficiency. Controllers for brush motors however are much simpler and cheaper due to the fact they don't require hall sensor feedback and are typically designed to be open-loop controllers.

3.4 Alternator

An alternator is an electromechanical device that converts mechanical energy to electrical energy in the form of alternating current. The brushes in an alternator carry only excitation current, a small fraction of the current carried by the brushes of a DC generator, which carry the generator's entire output. A set of rectifiers (diode bridge) is required to convert AC to DC. To provide direct current with low ripple, a three-phase winding is used and the pole-pieces of the rotor are shaped (claw-pole) to produce a waveform similar to a square wave instead of a sinusoid. We have used alternator of Yamaha bike which works at high RPM since our e-bicycle is limited to low RPM so we altered the windings of alternator and increases the drive ratio. So, that it can function at low RPM.

Fig 3.4

4. DESIGN AND FABRICATION

4.1 Design

Not all electric bicycles take the form of conventional push-bikes with an incorporated motor, such as the cytronex bicycles which use a small battery disguised as a water bottle Some are designed to take the appearance of low capacity motorcycles, but smaller in size and consisting of an electric motor rather than a petrol engine.
Our design used the concept of rear wheel drive which gets torque from motor Which in turn gets power by battery of 24 volts,5 ampere. in this design along with the charging of battery through main source it is also charged through alternator which is driven by front wheel friction drive working effectively in down hills Making it a dual rechargeable bicycle and thus useful in many areas specially college campuses, hospitals where noise pollution is not acceptable

4.2 Fabrication

Table-1 Name of Items & Specification

S. No.	Name of items	Specifications
1	Motor power	0.5 hp
2	Battery	24 V,5amp
3	Battery discharge time	1.8 hrs
4	Wheel Base	1.2 mtr
5	Gross Weight	73 Kg
6	Net weight	23 Kg.
7	Battery weight	2 Kg
8	Motor weight	3 kg
9	Alternator weight	3 kg
10	brakes	Shoe Brake (all wheels)
11	alternator	Low RPM
12	Rear wheel sprocket teeth	50
13	Motor Gear teeth	20

5. EXPERIMENTATION

5. 1 Testing Results

- Battery = 16 volt
- At motor= 15volt
- Max speed= 12 kmph
- Cycle Rpm= 80-100
- Discharging time = 1hr 45 min
- alternator diameter : cycle diameter = 1: 10

- voltage produced = 0.45 -0.65 volt
- current produced = 5.09 amp
- charging time=2 hours

6. RESULTS AND DISCUSSIONS

6.1 Analysis

6.1.1 Gearing

The motor uses a gear ratio of 5:2.The rear shaft is driven by a 50 teeth chain drive which is rotated by a 20 teeths gear driven by motor.
Motor power is 0.5hp/373 watts.
The motor gets power by a combination of 2 battery 12 volts 5 ampere connected in series conbination.
Sprocket is connected through welding on rear hub.
The motor is mounted on 3 mm steel sheet by 8mm bolt.
For self charging alternator is capable of producing 3.09watt when we are moving at 10 km/hr which is driven by front wheel.

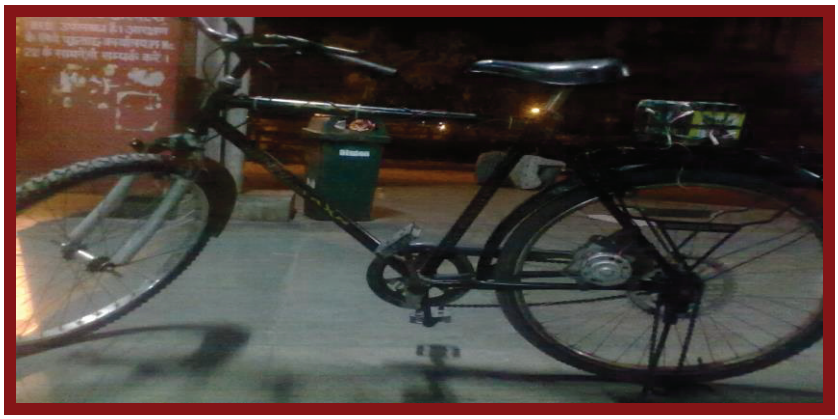

Fig 7.1

6.1.2 Switch over

Switch over which is used to engage / disengage the alternator is manually controlled and is made of iron rod, steel sheet and a link. it is a kind of a lever. The switch over to self charging is achieved by the use of lever which is manually controlled.

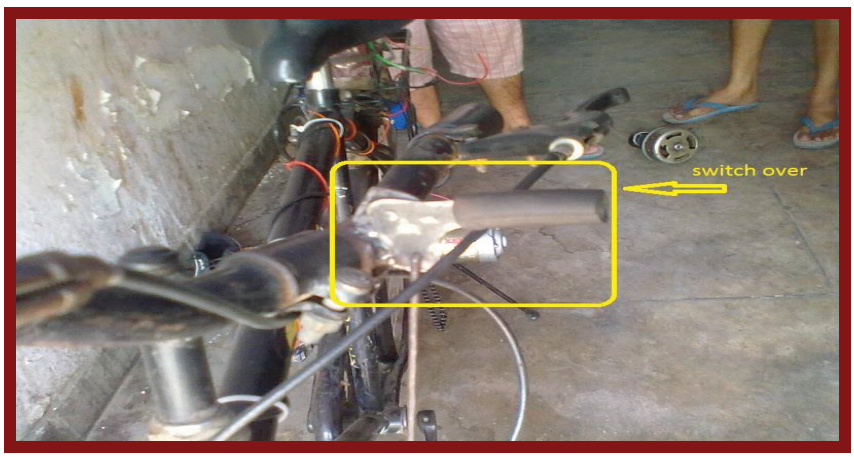

Fig 6.2.

6. 2 Cost

The majority of the cost of the initial prototype is found in the price of the motor, bicycle, battery and alternator. We are expecting however that almost all bicycle would be constructed from second hand parts, such that the cost would not be prohibitive. The motor and alternator, which are the main part of the bicycle used in our design, is usually much more resilient and remains functional after long run. Taking all these factors into account, the maximum component price for the dual chargeable electric bicycle is estimated to be around Rs 12000.

6.2.1 Bill of material

Table-2Items cost

S.NO.	NAME OF THE ITEM	COST(Rs.)
1.	Motor	4000
2.	Alternator	3000
3.	Battery	700
4.	Bicycle	1500
5.	Electric welding & turning operation	300
6.	Iron pipe	300
7.	Cycle spocket	200
8.	Gear set	300
9.	Relayand diode	50
10.	Chain set	200
11.	Switch	100
12.	Electric wire	50
13.	Mechanic work	100
14.	nut bolts	200
15.	Switch over	100
16.	Iron sheet	100
17.	Transportation	1000
	Total cost	12200/-

6.3 Advantages & Application

- Economic benefits.
- Eco friendly.
- Low accidental risk.
- Save of fuel resources.
- Easy handling.
- More efficient.
- Less effort more power.
- Benificial for hilly region
- No pollution
- No need for charging in EB supply
- No gear, carburetor, engine, etc.
- No starting troubles
- Noise level is very low.
- No need external energy supply
- Easy opera table

7. Conclusions

The following conclusions can be drawn from the present study

- When the battery is fully charged a speed of 10-15km/hr is obtained.
- When comming down the hill the charging can be achieved in 1hr.
- Because of friction driven mechanism wheel wear at a faster rate.

8. Scope for further Improvement

- We can mount the alternator on back wheel so that it can reduce the effort when the alternator is engaged.
- The design of the cycle should be aerodynamic to reduce the air drag to increase the speed.
- Battery of higher volts can be used according to the requirement.
- Stress analysis can be done for proper balancing of the electric bicycle.
- Use of gear shifter to reduce further effort.
- Electronic Display system can be used to know the amount of battery left.
- It should be made ergonomically.

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