DESIGN AND MODIFICATION OF BICYCLE BY USING ADDITIONAL SPROCKETS

Sanjeey Reddy K Hudgikar[1] S.M.Saleemuddin[2]

[1] *Professor, Mechanical Department, Lingaraj Appa Engineering College,Bidar,Karnataka,India*
[2] *Assistant Professor, Mechanical Department, Annamachara Institute of Technology & Sciences,Rajampet,Kadapa,AP.*

ABSTRACT

Biking is increasingly being recognized as a highly sustainable form of transportation. The present work focus on design and development of bi-cycle which can be implemented as an alternative to the two wheelers consuming large amount of fuel and polluting the environment. To overcome these problems, an effort is being made to search some other for the vehicles. Again, it is also not affordable to purchase vehicles (mopeds, scooters or motorcycles) for all the class of society. Keeping this in mind, a search for some way to cater these economically poor people as well as to provide a solution for the environmental pollution was in progress. This work deals with these problems efficiently as energy is generated utilizing the mechanical energy of the rider.

Keyword: - *Sprockets, Welding, Gear Mechanism*

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1. INTRODUCTION

A bicycle, often called a bike or cycle, is a human-powered, pedal-driven and 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 as of 2003, more than 1 billion have been produced worldwide twice as many as the number of automobiles that have been produced. They are the principal means of transportation in many regions. They also provide a popular form of recreation have been adapted for use as children's toys, general fitness, military, police applications, courier services and bicycle racing.

The basic shape and configuration of a typical "safety bicycle" has changed little since the first chain-driven model was developed around 1885. But many details have been improved, especially since the advent of modern materials and computer-aided design. These have allowed for a proliferation of specialized designs for many types of cycling. The bicycle's invention has had an enormous effect on society, both in terms of culture and of advancing modern industrial methods. Several components that eventually played a key role in the development of the automobile were initially invented for use in the bicycle, including ball bearings, pneumatic tires, chain-driven sprockets, and tension-sprocket wheels.

1.2 Types

Bicycles can be categorized in many different ways: by function, by number of riders, by general construction, by gearing or by means of propulsion. The more common types include utility bicycles, mountain bicycles, bicycles, touring, hybrid bicycles and cruiser bicycles and BMX bikes. Less common are tandems, low riders, tall bikes, fixed gear, models, amphibious and recumbent.

Unicycles, tricycles and quadra cycles are not strictly bicycles, as they have respectively one, three and four wheels, but are often referred to informally as "bikes".

1.3 PARTS OF BICYCLE

1.3.1 Steering

The handlebars turn the fork and the front wheel via the stem, which rotates within the headset. Three styles of handlebar are common.Upright handlebars, the norm in Europe and elsewhere until the 1970s, curve gently back toward the rider, offering a natural grip and comfortable upright position. Drop handlebars "drop" as they curve forward and down, offering the cyclist best braking power from a more aerodynamic "crouched" position, as well as more upright positions in which the hands grip the brake lever mounts, the forward curves, or the upper flat sections for increasingly upright postures. Mountain bikes generally feature a 'straight handlebar' or 'riser bar' with varying degrees of sweep backwards and centimeters rise upwards, as well as wider widths which can provide better handling due to increased leverage against the wheel.

1.3.2 Seating

Saddles also vary with rider preference, from the cushioned ones favored by short-distance riders to narrower saddles which allow more room for leg swings. Comfort depends on riding position. With comfort bikes and hybrids, cyclists sit high over the seat, their weight directed down onto the saddle, such that a wider and more cushioned saddle is preferable. For racing bikes where the rider is bent over, weight is more evenly distributed between the handlebars and saddle, the hips are flexed, and a narrower and harder saddle is more efficient. Differing saddle designs exist for male and female cyclists, accommodating the genders' differing anatomies, although bikes typically are sold with saddles most appropriate for men.

A recumbent bicycle has a reclined chair-like seat that some riders find more comfortable than a saddle, especially riders who suffer from certain types of seat, back, neck, shoulder, or wrist pain. Recumbent bicycles may have either under-seat or over-seat steering.

1.3.3 Brakes

Bicycle brakes may be rim brakes, in which friction pads are compressed against the wheel rims; hub brakes, where the mechanism is contained within the wheel hub, or disc brakes, where pads act on a rotor attached to the hub. Most road bicycles use rim brakes, but some use disk brakes. Disc brakes are more common for mountain bikes, tandems and recumbent bicycles than on other types of bicycles, due to their increased power, coupled with an increased weight and complexity.

Track bicycles do not have brakes, because all riders ride in the same direction around a track which does not necessitate sharp deceleration. Track riders are still able to slow down because all track bicycles are fixed-gear, meaning that there is no freewheel. Without a freewheel, coasting is impossible, so when the rear wheel is moving, the cranks are moving. To slow down, the rider applies resistance to the pedals, acting as a braking system which can be as effective as a conventional rear wheel brake, but not as effective as a front wheel brake.

1.3.4 Suspension

Bicycle suspension refers to the system or systems used to suspend the rider and all or part of the bicycle. This serves two purposes: to keep the wheels in continuous contact with the ground, improving control, and to isolate the rider and luggage from jarring due to rough surfaces, improving comfort.

Bicycle suspensions are used primarily on mountain bicycles, but are also common on hybrid bicycles, as they can help deal with problematic vibration from poor surfaces.

Suspension is especially important on recumbent bicycles, since while an upright bicycle rider can stand on the pedals to achieve some of the benefits of suspension, a recumbent rider cannot.

1.3.5 Wheels and tires

The wheel axle fits into fork ends in the frame and fork. A pair of wheels may be called a heel set, especially in the context of ready-built "off the shelf", performance-oriented wheels.

Tires vary enormously depending on their intended purpose. Road bicycles use tires 18 to 25 millimeters wide, most often completely smooth, or slick, and inflated to high pressure in order to roll fast on smooth surfaces. Off-road tires are usually between 38 and 64 mm (1.5 and 2.5 in) wide, and have treads for gripping in muddy conditions or metal studs for ice.

1.4 Various transports in India

Normally the average utilization of multi-speed gear system is less than 40%. Displays the nominal gear values in commercialized multi-speed gear system and their actual gear ratios. Thus, with respect to human performance and power efficiency, current design of gear system is efficient and easy to use because of increase in the speed.

Category	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08
Three-wheeler	231,529	284,078	307,862	359,920	403,910	364,703
Two-wheeler	4,812,126	5,364,249	6,209,765	7,052,391	7,872,334	7,248,589

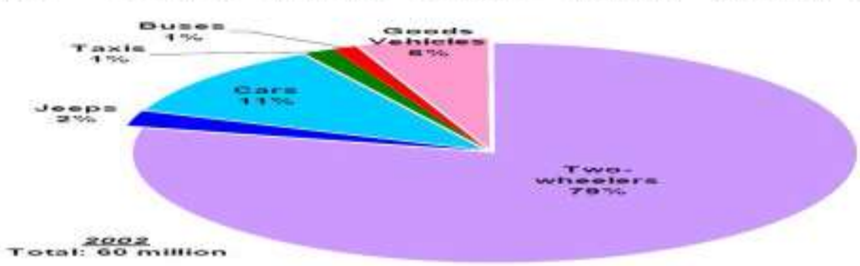


Fig:-1.4 Pie chart depicting the use of various transports in India

1.5 Pedal power

Pedal power is the transfer of energy from a human source through the use of a foot pedal and crank system. This technology is most commonly used for transportation and has been used to propel bicycles for over a hundred years. Less commonly pedal power is used to power agricultural and hand tools and even to generate electricity.

1.6 Sprocket

A sprocket or sprocket-wheel is a profiled wheel with teeth, cogs, or even sprockets that mesh with a chain, track or other perforated or indented material. The name 'sprocket' applies generally to any wheel upon which are radial projections that engage a chain passing over it. It is distinguished from a gear in that sprockets are never meshed together directly, and differs from a pulley in that sprockets have teeth and pulleys are smooth.

Sprockets are used in bicycles, motorcycles, cars, tracked vehicles, and other machinery either to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a track, tape etc. Perhaps the most common form of sprocket may be found in the bicycle, in which the pedal shaft carries a large sprocket-wheel, which drives a chain, which, in turn, drives a small sprocket on the axle of the rear wheel. Early automobiles were also largely driven by sprocket and chain mechanism, a practice largely copied from bicycles.

Sprockets are of various designs, a maximum of efficiency being claimed for each by its originator. Sprockets typically do not have a flange. Some sprockets used with timing belts have flanges to keep the timing belt centered. Sprockets and chains are also used for power transmission from one shaft to another where slippage is not admissible, sprocket chains being used instead of belts or ropes and sprocket-wheels instead of pulleys. They can be run at high speed and some forms of chain are so constructed as to be noiseless even at high speed.

1.7 Gearing

Typically there are several gears available on the rear sprocket assembly, attached to the rear wheel. A few more sprockets are usually added to the front assembly as well. Multiplying the number of sprocket gears in front by the number to the rear gives the number of gear ratios, often called "speeds".

Hub gears use epicyclic gearing and are enclosed within the axle of the rear wheel.
Because of the small space, they typically offer fewer different speeds, although at least one has reached 14 gear ratios and Fallbrook Technologies manufactures a transmission with technically infinite ratios.

2.LITERATURE REVIEW

1. **Ram Singh and Prof. Mrs. D.C. Sharma** *have proposed that during working on experimental setup and after a long discussion in the paper of " A Review of Experimental study of home automation by bicycle pedal power". This study attempts to measure the optimal pedaling rates for given power output levels as well as design the optimal number of gears and the corresponding gear ratios. Heart rate, ratings of perceived exertion and electromyogram of quadriceps femoral for male subjects are measured at three different power output levels (40, 80 and 120 W) and four different pedaling rate levels (40, 60, 80 and 100 rpm). Various riding conditions including slope gradient and cruising velocity are also converted to the equivalent power output level.*

2. Swapnil Shringarpure, Pranjal Upadhyay, Abhishek Bhalotia and Dhiraj Sambhwani *have proposed that during working on experimental setup and after a long discussion in the paper of "Automated bicycle" In order to cope with the lightning speed of life these days quick transportation has been one of the important factor, in one way the fast transport provide us with the modern needs of life, but on the other side the it has resulted in increased consumption of fuels and also played a crucial role in increasing pollution. This research deals with these problems efficiently as energy is generated utilizing the mechanical energy of the rider. The state of the art, general calculus and future developments are shown.*

3. Sreevalsan S Menon, Sooraj M S, Sanjay Mohan, Rino Disney and Suneeth Sukumaran *has proposed that during working on experimental setup and after a long discussion in the paper of "Design and analysis of kinetic energy recovery system in bicycles". When riding a bicycle, a great amount of kinetic energy is lost while braking, making start up fairly strenuous. Here we used mechanical kinetic energy recovery system by means of a flywheel to store the energy which is normally lost during braking, and reuse it to help propel the rider when starting. The rider can charge the flywheel when slowing or descending a hill and boost the bike when accelerating or climbing a hill. The flywheel increases maximum acceleration and nets 10% pedal energy savings during a ride where speeds are between 12.5 and 15 mph.*

4. **Anmol Parashar** and **Seemant Purohit** *have proposed that during working on experimental setup and after a long discussion in the paper of "Design & Fabrication of Shaft Driven Bicycle". Usually in two wheelers, chain and sprocket method is used to drive the back wheel. Shaft -driven bikes have a large bevel gear where a conventional bike would have its chain ring.*

This meshes with another bevel gear mounted on the drive shaft. The use of bevel gears allows the axis of the drive torque from the pedals to be turned through 90 degrees. The drive shaft then has another bevel gear near the rear wheel hub which meshes with a bevel gear on the hub where the rear sprocket would be on a conventional bike, and cancelling out the first drive torque change of axis.

5. Shishir S, Manjunath P, Pavanasudan R, and Ravi Sathyajith *has proposed that during working on experimental setup and after a long discussion in the paper of "Design and Fabrication of Foldable Bicycle". To cope with time deficit, we can utilize the time spent on commuting efficiently to exercise by using bicycles, thereby also contributing to pollution control. But regular bicycles occupy sufficient space to park, are not easy to carry around and are*

probable to theft. Transport has been one of the most important issues to be dealt with in the present day situation as commuting from place to place within the city has become a tedious and an expensive task. It is very difficult to reach the nearest public transport facility and in many cases the destination will be very far from the main roads where the public transport might not be able to commute or it might be very expensive. To overcome a common problem faced by the society, an idea is conceptualized to design and fabricate a foldable bicycle. We already have seen many foldable bicycles in the global market but the main idea of this project is to provide a foldable bicycle which is light & sleek yet rigid & safe, easy to handle and easy to maintain. Unlike the conventional cycles, this bicycle will occupy very less space and also is very easy to be carried around. The main objective is to design and develop a foldable bicycle which is comfortable to ride and economical.

3. METHODOLOGY

Based on the previous techniques which are meant for the development of bicycle and its evolution we started a new innovation among bicycles which will be a alternate to motor cycles or mopeds that consumes lot of fuel.

The main objective of our project is to improve the speed of bicycle. In order to improve the speed certain changes in its design is to be done. The main change we did is adding one more sprocket, hub, free wheel and required length of chain.

The hub is a hallow tube which is used to hold the folk sticks between the rim of a tire. In our project we used the hub to fix the two toothed wheels on it. To fix the hub we made holding clamps in between the seating rod. The clamps are made up of iron or we can select any material that is useful and easily available. The clamps are welded on the seating rod with arc welding. Because, Arc welding has good depth of penetration to with stand the load. Then the free wheel and sprocket are welded on the hub with gas welding because with arc welding the bearing balls will melt and becomes powder. For inserting the sprocket on to the hub we need to enlarge the hole of the sprocket similar to the diameter of hub external diameter by lathe. The free wheel consists of inner thread and hub consists of external threads on one side to screw the free wheel in normal cycles. For our convenience we screwed the free wheel in opposite direction and did gas welding to fix it.

Now, the hub with two toothed wheels is inserted into the holding clamps and screwed it with nuts to the hub axle. The hub axle is a rod with 8 mm diameter.

Now, the main sprocket which is used for pedaling is shifted to other side of bicycle to get the free wheel on the hub to be inline and connected with chain. Same, the sprocket on the hub is connected to the main free wheel with chain. The sprocket comes with a pedal crank welded to it. In order to remove the pedal crank it is grinded and separated. Now, the crank wheel has a small whole in the centre with some diameter. In order to fix it on to the hub we need the enlarge the whole up to the hub external diameter. So, we've done boring in lathe and extended the whole. Now the sprocket is ready to fix on the hub.

3.1 Welding work:

In this work we have used two types of welding's.

1. *Arc welding*
2. *Gas welding.*

3.1.1 Arc welding

Arc welding is used to weld the clamps on the bicycle seating rod to hold the hub. Arc welding has good depth of penetration and gives good strength to the clamps for holding the hub. The clamps are made up of iron with 5 mm thickness and30 mm width with suitable length. Here we have made two clamps one with 47 mm length with a small hole drilled at one end with a diameter of hub axle.

Fig:-3.1 Clamp1

And another one with a length of 122 mm. It is provided with a small iron plate cross to its length and a small hole is provided for hob axle and is welded.

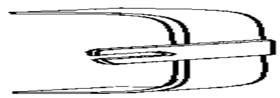


Fig:-3.2 Clamp2

3.1.2 Gas welding

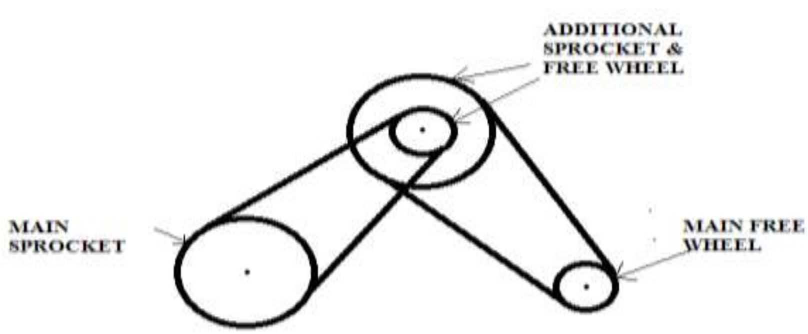
Gas welding is used for sensitive parts. In our work the sensitive parts are hub, sprocket, and free wheel. Mainly these parts are welded using gas welding. The sprocket we have altered is fixed on to the hub and is welded on both sides for safety. Now, the free wheel is runned over the dye in opposite direction and welded on both sides for safety. The material used for gas welding is brass.

3.2Installation :

now the hub is set into the clamps and is fitted with nuts. The main sprocket is shifted to the other side for making free wheel inline. The sprocket on the hub is set inline with rear free wheel. Now, the toothed wheels are connected with chain for power transmission.

3.3 Working :-

The force applied on the pedal is transformed to main sprocket, the main sprocket transfers the motion to the additional free wheel. As the additional free wheel and additional sprocket is mounted on the same axis the motion from additional sprocket is transformed to the main free wheel. Here as we are using additional sprocket and free wheel the rpm is going to be improved based on the gear ratios.

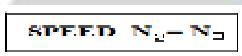


Fig;-3.3 chain sprocket mechanism

3.4 Final product

Fig 3.4: Final Product

3.5 CALCULATION



3.5.1 Specifications

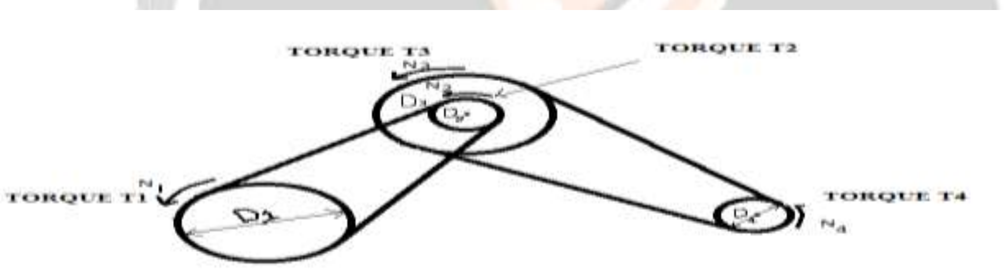


Fig 4.5.1 Specifications

Sprocket:-
Number of teeth on the sprocket $Z_s = 44$
Diameter of the sprocket $D_1 = 180mm$
Freewheel:-
Number of teeth on the freewheel $Z_f = 18$
Diameter of the freewheel $D_2 = 82mm$
Assumption:-
Mass of the rider = 100kg
Speed of the sprocket at the pedle $N_1 = 100rpm$

4.5.2 Calculation for sprocket and chain drive mechanism

$T_1 = f_1 * r_1$
Where
- T_1 = *Torque on the sprocket*
- F_1 = *Force of the rider* ($f_1 = m*g$)
- $g = 9.81\ m/s^2$
- *r1=Radius of the sprocket = 90mm*

$T_1 = 100*9.81*0.09$
$T_1 = 88.29N\text{-}m$
Velocity ratio $v = Z_s/Z_f$
$= 44/18$

$V = 2.44$

*Pitch circle diameter = p*cosec*(180/z)*

Where

p = chain pitch

$p = 12.7mm$

z = Number of teeth on sprocket or free wheel

Pitch circle diameter sprocket $d_1 = p*cosec*(180/Z_s)$

$= 12.7*cosec*(180/44)$

$d_2 = 178.02mm$

Pitch circle diameter freewheel $d_2 = p*cosec*(180/Z_f)$

$= 12.7*cosec*(180/18)$

$d_2 = 73.13mm$

Relation between speed and number of teeth on sprocket or free wheel

$N_2 = (N_1*Z_s)/Z_f$

$= (100*44)/18$

$N_2 = 244.44rpm$

Power $P_1 = 2\pi N_1T_1 / 60$

$= (2\pi*100*88.29)/60$

$P_1 = 924.57w$

Pitch line velocity sprocket

Velocity $V_1 = \pi\, d_1N_1/60$

$= \pi*0.178*100/60$

$V_1 = 0.93m/s$

Load on chain f_2 = rated power/pitch line velocity

$f_2 = 924.57/0.932$

$f_2 = 992.02N$

r_2 = radius of the freewheel

Torque $T_2 = f_2*r_2$

$= 992.02*0.041$

$= 40.67N\text{-}m$

$f_2 = f_3,\ N_2 = N_3$

Because the freewheel and sprocket placed on same shaft

Torque $T_3 = f_3*r_3$

$= 992.02*0.09$

$T_3 = 89.28N\text{-}m$

Power $P_3 = 2\pi N_3T_3 / 60$

$= (2\pi*244.44*89.28) / 60$

$P_3 = 2285.36N\text{-}m$

Velocity $V_2 = \pi\, d_2N_2/60$

$= \pi*0.073*244.44/60$

$V_1 = 0.934m/s$

Load on chain $f_4 = 2285.36/0.934$

$= 2446.85N$

Torque $T_4 = f_4*r_4$

$= 2446.85*0.041$

$T_4 = 100.32N\text{-}m$

Velocity ratio $v = (N_4/N_3)$

$2.44 = (N_4/244.44)$

$= 2.44*244.44$

$N_4 = 596.43rpm$

3.6 COMPARISON WITH CONVENTIONAL CYCLE

3.6.1 Table:- Comparison of speed

Conventional cycle	**Modified design cycle**
N1=100rpm	*N1=100rpm*
N2=244.44rpm	*N2=244.44rpm*
	N3 =244.44rpm
	N4=596.43rpm

3.6.2 Table:- Comparison of torque

Conventional cycle	**Modified design cycle**
T1=88.29N-m	*T1=88.29N-m*
T2=40.66N-m	*T2=40.66N-m*
	T3=89.28N-m
	T4=100.32N-m

4. CONCLUSION

The work is done to reduce the human power by producing more no of rotations to the same torque. The transmission capacity of the bicycle using new mechanism has been calculated by neglecting the effect of centrifugal forces. Instead of single chain drive additionally use of another chain drive that creates a new mechanism it increases the speed of bicycle. This work also deals with the ratios of the velocity and it is compared with the speed of conventional bicycle and observed the speed is increased by 2.5 times. The results obtained from this work is a useful approximation to help in the earlier stages of the development and helping in the decision making process to optimize a design. This new mechanism has served as an alternative to a single chain drive in bicycles for the future.Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work.

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