Flywheel Bicycle

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Abstract

The bicycle invention had an enormous effect on society, both in terms of culture and of advancing modern industrial method. But now-a-days there is decrease in use of bicycle. Because the main drawback with conventional bicycles is that more efforts are needed while travelling on a gradient and energy used by the bicycle is more. For minimizing this problem, we are using kinetic energy recovery system by designing the flywheel for recovering the moving bicycle energy under breaking and also to convert the usual loss in kinetic energy into gain in kinetic energy. When riding a bicycle, a great amount of kinetic energy is lost while breaking. To use this energy, we are using a flywheel to store the energy which is normally lost during breaking and reuse it to help propel the rider when starting. By designing the flywheel which is more suitable to the frame properties and rider compatibility the efforts of the rider can be reduce. The rider can charge the flywheel during downward motion on hilly road and boost the bicycle when accelerating. This project preliminary deal with one of the method for recovering the kinetic energy from the Flywheel, which is implemented in a bicycle. In this we are concentrating on the mass of the flywheel and re-designing it.
Keywords: Flywheel, KERS

I. Introduction

In a world where almost all its fuel is being depleted, conservation of natural resources has become a necessity in today's world especially in the field of renewable technology. In an automobile maximum energy is lost during deceleration or braking. This problem has been resolved with the introduction of regenerative braking. It is an approach to recover or restore the energy lost while braking. The Kinetic Energy Recovery System (KERS) is a type of regenerative braking system which has the capability to store and reuse the lost energy. It (KERS) is a system which first stores the kinetic energy in the form of useful energy and recovers back as requirement. In other words KERS is collection of parts which stores some of the kinetic energy of the vehicle under deceleration and then releases the stored energy back into the drive train of the vehicle. Kinetic energy recovery system (KERS) store energy when the vehicle is braking and returns it when accelerating. It is used for providing a power boost to the vehicle.

There are two basic types of KERS systems i.e. Electrical and Mechanical. The main difference between them is the way they convert the energy and how that energy is stored within the vehicle. Battery based electric KERS system require a number of energy conversions each with corresponding efficiency losses. On reapplication of the energy to the driveline, the global energy conversion efficiency is 31-34%. The mechanical KERS system storing energy mechanically is a rotating fly wheel which eliminates the various energy conversions efficiency. This design of KERS bicycle was motivated by a desire to build a flywheel energy storage unit as a proof concept.

II. Literature review

First flywheel model evolved long back in 18th century, but rapid development in this field initiated since mid of 19th century. Radhika Kapoor. Et.al [1] highlighted different ways of recovering energy using flywheel, batteries or super capacitors, hydraulic or hydro-electric actuators. Kevin Ludlum. Et.al [2] discussed about the kinetic energy storage and weight requirement for the flywheel. Thus we came to select the flywheel of mass 8kg. Sreevalsan.S. Et.al gave an idea about mounting of flywheel and working details.

III. Methodology

By studying the various literatures regarding to the project we come to know that, the weight of flywheel is more as compare to the efficiency of the bicycle. The design is based on the weight of flywheel and design of the bicycle body. As we are going to reduce the weight of flywheel, the stresses produce in connecting rod will also decrease and power required to drive the bicycle will also reduce.

The material used for fabrication of the flywheel is cast iron which is brittle virtually non-malleable metal that is considered generally inflexible. The stiffness and dampening properties of cast iron make it an excellent material for flywheel.

Fig. 1: Flywheel bicycle

By fabricating the flywheel and designing it according to the main frame and design of bicycle we got good stability of the bicycle. The frame had modified by adding steel tube which is of square shape. One end is welded at the handle end and the other at the rear frame of bicycle.

IV. RESULTS AND DISCUSSION

The flywheel bicycle increases efficiency on rides where the rider slows often. The additional weight is outweighed by the ability to recover energy normally lost during braking. Thus the addition of extra weight does not make it difficult for the rider. The overall result is that KERS system is efficient in storing energy normally lost in braking and returns it for boosting.

A. *Weight and Performance*

Normally energy stored in the flywheel is directly proportional to the weight and radius. Hence increase in the weight proves to improve the performance. But as we know that the maximum safe weight that can be used is limited due to frame properties and rider compatibility. And also after some extent radius can’t be increased and the energy storage thus seems to be limited to some particular extent. This is also because of the fact that the total running speed is being reduced due to weight. Energy storage capacity increases with increase in weight but limitations seem to be the speed driving the flywheel and the performance of the system is directly linked with the energy stored. Thus a graph can be plotted between performance and weight. Optimum value lies between 5 and 8kg.

$$E = \frac{1}{2} I\omega^2$$

Where,

$$I = \frac{1}{2} m (r_1^2 - r_2^2)$$

Where m is the mass of the flywheel, I is the moment of inertia of flywheel, r1 and r2 are the inner and outer radius of the flywheel respectively. Thus E is directly proportional to the mass of the disc.

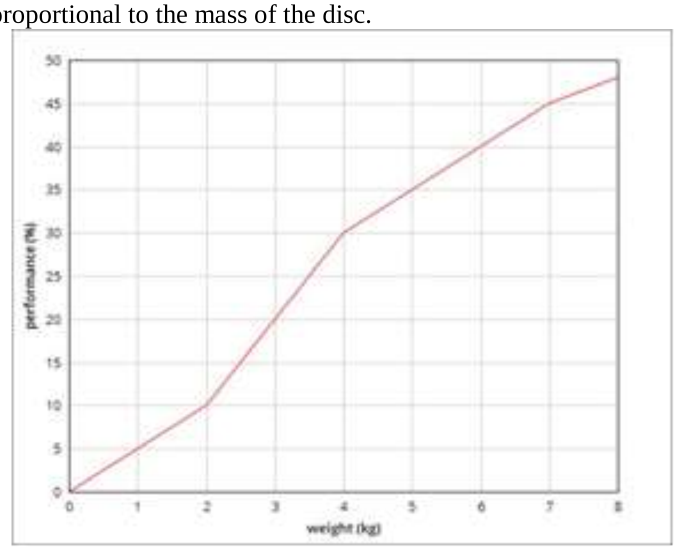

Fig. 2: Weight vs. performance graph

The flywheel and transmission add weight to the bicycle. The increased weight will add to the energy required to accelerate the bicycle and to ride it uphill. However, once the rider has provided the energy to which a cruising speeds, the flywheel reduces the energy cost of slowing down from this speed since it aids in subsequent acceleration. Roads are optimal environment for the flywheel bicycle because it's flat and there are lots of reasons for the cyclist to slow down

B. Comparison Analysis

Comparison is made between conventional bicycle and the KERS bicycle. The major things looked up was velocity, kinetic energy and pedaling power. Velocity of both seemed to be similar but the distance covered by flywheel is somewhat greater. The flywheel has an extra kinetic energy that is being stored and hence from conventional bicycle flywheel bicycle is having an additional kinetic energy of flywheel. Flywheel bicycle has additional acceleration that is being boosted up by the flywheel acceleration. Hence conventional bicycle pedaling power can be achieved by less effort in case of flywheel bicycle.
Observations are taken by comparing KERS bicycle with ordinary bicycle. The table is as given.

Table – 1
Comparison

Parameter	*Ordinary bicycle*	*Flywheel bicycle*
Total distance travelled	*60m*	*70m*
Pedaling distance	*19m*	*19m*
Non pedaling distance	*41m*	*50m*
Energy of system	*1234.76 J*	*1358.2419J*
@ 20kmph		
Flywheel effect	*No effect*	*Energy storage*
Bicycle speed	*20kmph*	*20kmph*
Flywheel mass	*0kg*	*8kg*
Starting torque	*less*	*more*

C. Overdrive Test

This test was carried out to find out how much pedaling power can be saved by having KERS bicycle. This was done by riding the bicycle on a road and initial pedaling was given same and noted down the distance at which bicycle stops when flywheel is not being connected. Then take 10m back point from the stopping distance. The experiment was again done by riding cycle with flywheel coupled from 10m side and noted down the extra distance covered by the bicycle. The result was tabulated. The values reveal the total gain in energy of about nearly 10 percent. Thus flywheel bicycle can help in reducing the overall pedaling power by 10 percent used in overdrives.

Table – 2
overdrive test

No. of trails	*Distance covered*	
	Flywheel engaged	*Flywheel disengaged*
1	*10m*	*10.60m*
2	*10m*	*10.76m*
3	*10m*	*10.72m*
4	*10m*	*10.86m*

V. CONCLUSION

KERS system used in the vehicles satisfies the purpose of saving a part of the energy lost during slowing down. Results from some of the test conducted show that around 30% of the energy delivered can be recovered by the system. KERS system has a wide scope for further development and the energy savings. The use of more efficient systems could lead to huge savings in the economy of any country. Here we implemented the KERS system in a bicycle with an engaging and disengaging lever mechanism for gaining much more efficiency. As many mating parts are present, large amount of friction loss is found in this system which can be improved. Boost is reduced because of friction.
We can improve and optimize the functioning of KERS by little modifications in our project.
1) By in cooperating by carbon fibre frame in place of iron rod frame which is in light weight.
2) We can also fabricate lever mechanism with the plastic which in turn reduces its weight up to certain limit.
3) We can change the design of flywheel. In new design more mass will be distributed on outer side of the disc.
4) By increasing the number of teeth on rear wheel sprocket, energy storage can be increased.

By making all these changes it would be easier to ride and move comfortably.

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