International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 5, Sept-Oct-2020, ISSN (Online): 2395-566X

Review on Kinetic Energy Recovery System for Bicycle

Abhijit d Panchbhai, Shubham Dhumane, Prof. G.P. Dhalwar
Department of Mech. Engg.
B.D.C.E. Sevagram
rockabhi786@gmail.com,shubhamdhumne4@gmail.com, shyamdhalwar@gmail.com

***Abstract* – This paper is a literature review on KERS for bicycle. Kinetic Energy Recovery System, commonly abbreviated KERS, is a system to recover the Kinetic energy of a moving vehicle under braking. This system stores the kinetic energy in the form of potential energy and converts it back to kinetic energy when needed. When riding a bicycle it becomes too tiresome to start the bicycle again after braking. If the bicycle is provided with a kinetic energy recovery system then the rider will have two power sources that he can use at his will. When brakes are applied kinetic energy is wasted because the kinetic energy converts into heat energy due to friction at the contact surface and the heat energy dissipates into the atmosphere due to thermal radiation. Vehicles equipped with KERS devices are able to take some of its kinetic energy out slowing down the vehicle. This is a form of braking in which energy is not wasted, instead gets stored in some device. Using a proper mechanism, this energy that is stored in terms of potential energy can be converted back into kinetic energy to give the vehicle an extra boost of power. In the literature review different types of available KERS systems are compared and a mechanical based KERS system is found to be the best suitable for a bicycle.**

***Keywords* – KERS, KERS devices, braking, bicycle.**

I. INTRODUCTION

A kinetic energy recovery system abbreviated as KERS is an automotive system which recovers the kinetic energy of a moving vehicle under braking. The energy recovered is stored in terms of potential energy a reservoir for later use for acceleration. Examples of reservoir are high voltage batteries, flywheels, hydraulic coupling, etc. The selection of reservoir largely depends on the purpose.

In recent days recovering Kinetic energy has become an interesting area of research for many. Let us first find out why? The total energy in this universe can be broadly divided into two parts Potential Energy and Kinetic Energy. The Potential Energy is the energy possessed by the body due to its position or state where as the Kinetic Energy is the energy the body gains due to its motion.. For example a car possess some Kinetic energy with respect to road but with respect another car moving at same speed it has no Kinetic energy.

So when we need to impart motion into a body we have to convert some amount potential energy into Kinetic energy. When that body has to come to rest, that amount of kinetic energy needs to get converted into Potential energy. But in nature the form of potential energy to which the Kinetic energy gets converted is of a lower grade, in most of the cases, and is very difficult to reuse. Taking the example of a car, when we run a car we burn petrol and convert the potential energy of the petrol into the Kinetic energy of the car and when we apply the brakes the kinetic energy converts into heat energy in the brake callipers and eventually gets diffused into the atmosphere. If this energy would have been saved it could have been used. There are two type of Kinetic Energy Recovery Systems which have gained popularity in recent days. One is Electrical KERS and another is Mechanical KERS. Both have their respective pros and cons. [1]

Fig.1. KERS Bicycle[1].
(Source: Sreevalsm Et . 2013 "Design and analysis of kinetic energy recovery system in bicycles").

II. LITERATURE REVIEW

Exhaustive literature review is carried on KERS. The contribution on various research is presented below.
Sreevalsan Et. (2013) mentioned some of the most basic requirements of a KERS for bicycle. Energy should be stored during braking. Energy should be returned to the bicycle to start up. There must be simple way release the energy that is stored during braking in a positive way. The KERS system should be of light weight . The KERS should be able to slow down the system considerably

when the rider applies it. The stopping range should be less.

Shreemoy Kumar Nayak (2014-15) discussed the following points about flywheel based KERS system. A hybrid of clutch and CVT based KERS systems is expected to be cheaper than CVT based KERS system.

A thorough study by Radhika Kapoor and C. Mallika Parveen (2013) have shown the following points about flywheel which is capable of offering maximum steady voltage and power levels as compared to other types of storage systems.

Siddharth K. Patil (2012) discussed the regenerative braking system in automobiles for recovering the moving vehicle's kinetic energy under braking and also to convert the usual loss in kinetic energy into gain in kinetic energy.

D. Mojeswara Rao Et. (2017) mentioned KERS as a automotive system for recouping a moving vehicle's kinetic energy under braking. The recouped energy is put away in a reservoir, this reservoir may be high voltage batteries or a flywheel, for later used under acceleration.

COMPONENTS OF KERS:

The components required for the making of the KERS for a bicycle obtained from literature review are mentioned below.[2]

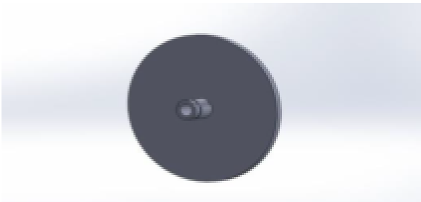

Fig 2. Flywheel.

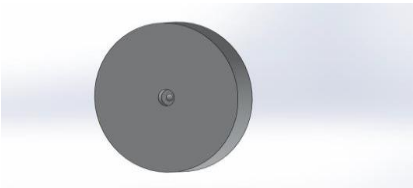

Fig.3. Clutch.

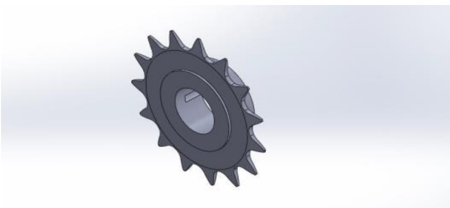

Fig.4. Front Sprocket.

Fig .5 Clutch Drive.

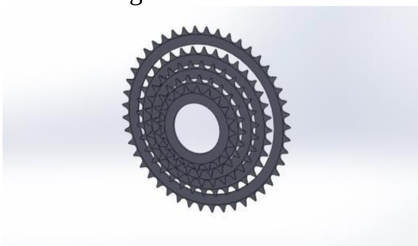

Fig.6. Rear Sprocket.

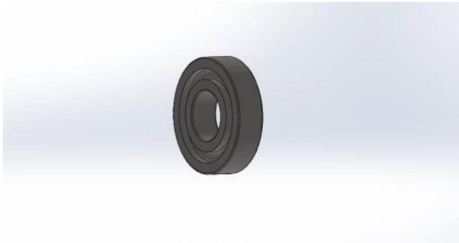

Fig .7. Ball bearing.

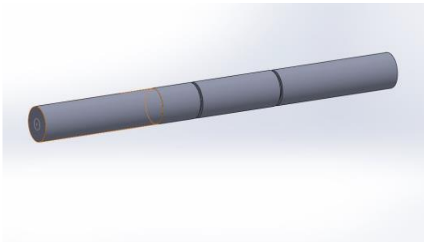

Fig .8. Central Shaft.

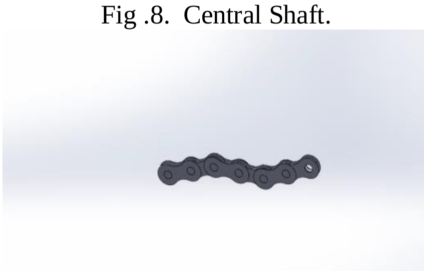

Fig .9 Chain.

(Source "Design of Kinetic Energy Recovery System for Bicycle, 2014-15)

Fabrication process

The fabrication process studied from literature review (Sreevalsm Et. 2013) is presented below:-

1. Frame Modification

The frame modification is the first part of the fabrication that has to be done. The frame has to be modified by adding steel tube. One end has to be welded at the handle end and the other at the rear wheel centre. The frame

International Journal of Scientific Research & Engineering Trends
Volume 6, Issue 5, Sept-Oct-2020, ISSN (Online): 2395-566X

should have enough strength so as to carry the flywheel and the additional forces that comes to play

2. Flywheel

The flywheel has to be bored centrally in order to place a ball bearing so that flywheel can rotate over the axle. Also flywheel has to be selected so that the selected weight does not affect the bicycle physics and riding performance of the rider. The performance of KERS system mainly depends upon the flywheel selection.

3. Clutch

A clutch has to be provided so as to control the power delivery and release from the flywheel. This can be achieved by providing a clutch plate that is linearly moved to and fro by applying a lever mechanism incorporated with a spring assembly for providing return mechanism.

4. Axle

The axle has to be made so as to carry the flywheel and clutch units. The axle should withstand the forces coming to play.

5. Sprocket

Two sprockets have to be used. The gear ratio is to be taken in to account here. One sprocket with higher number of teeth is to be selected and other having lesser number of teeth. The larger sprocket is to be placed at the rear wheel end and smaller sprocket at the axle end. This is to ensure that we can provide larger flywheel rotations so that energy storage increases.

The flowchart of the fabrication process is shown in the figure below.[1]

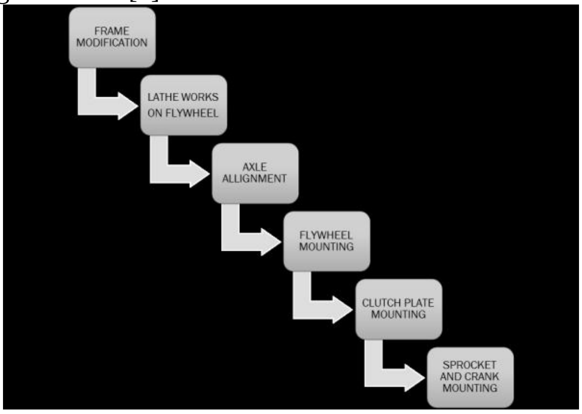

Fig. 11. abrication flowchart [1].

(Source: Sreevalsm Et. (2013) "Design and analysis of kinetic energy recovery system in bicycles".)

III. WORKING PRINCIPLE

The work principle of KERS is studied from a literature review of Sreevalsm Et. (2013) is presented below:-

A crank wheel connected to the rear wheels always rotates the clutch plate, connected in the flywheel axle. This is being achieved by using chain transmission at a specified gear ratio, crank to clutch sprocket helps us to increase the overall speed of flywheel. Now at a time when a speed reduction is required, clutch is applied which makes the contact between the clutch and flywheel. Then the flywheel starts rotating, also the speed of bicycle is decreased. Thus a regenerative braking system is achieved. On course energy is stored in flywheel. In case the brake has to be applied fully then after flywheel rotations clutch is disengaged and the brake is applied.

Now when we again rides the bicycle during which we would apply clutches at this time as rear wheel rotation is lesser compared to flywheel the energy gets transmitted from the flywheel to the wheels.

Now also we can reduce the overall pedalling power required in course of over rides by having clutch fully engaged. We can reduce overall pedalling power by 10 per cent. Also situation arises such as traffic jam, down climbing a hill where we do not intend to apply brake fully. For such cases we can apply our smart braking system which would allow us to decelerate and allow us to boost acceleration after this during normal riding and distance that can be covered by pedalling can also improve. During normal rides situations may arise we need to reduce the speed without braking fully such as traffic jams taking turns etc. we can store the energy that would normally be wasted due to speed reduction by the application of clutch. When the clutch is engaged that time due to initial engage the flywheel rotation consumes energy which would result in speed reduction thus a braking effect.

After some instances the energy is being stored in the flywheel this can be reused by the engage of clutch plate and energy transfer from the flywheel occurs whenever the rotation is high enough to rotate rear wheel. Thus if sudden braking then applied we can disengage the flywheel connections so that flywheel energy is not wasted and going to take ride the speed of rear wheel is null and hence engage would help in returning the energy from the flywheel to rear wheel. While riding downhill we always use braking for allowing slowdown. This is the best case where we can store maximum amount of energy in our flywheel. The flywheel can be engaged for full down hill ride and after all for some distance we need not ride the bicycle which would be done by the flywheel. This is the main advantage area of KERS bicycle. [1]

Views:

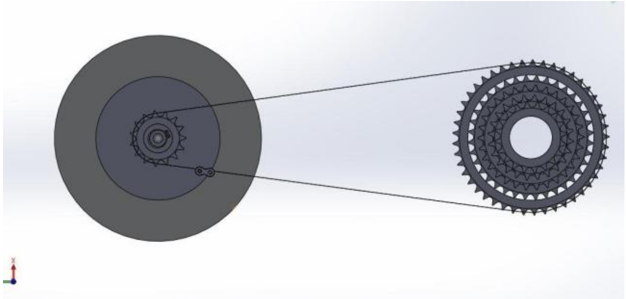

Fig .12 . Front View of the KERS [2].

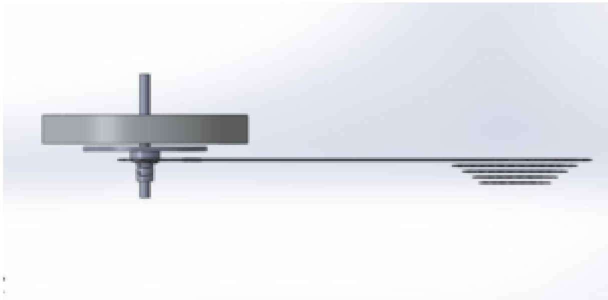

Fig.13.Top view of the KERS [2].

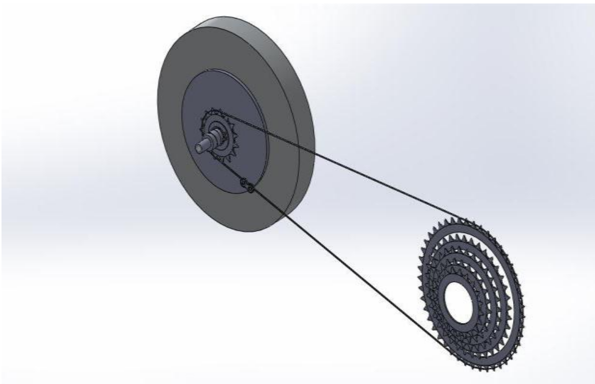

Fig.14. Isometric view of the KERS [2]
(Source: "Shreemoy Kumar Nayak, 2014-15).

Types of Kers :

1. **Mechanical KERS:**

The mechanical KERS utilises a flywheel as a flywheel as the energy storage device and a variable drive transmission to control and transfer the energy to and from the driveline [4]. The transfer of vehicle kinetic energy to flywheel kinetic energy can be seen as a momentum exchange. Energy is transferred from the vehicle to the flywheel. In doing this the speed of the vehicle decreases and that of the flywheel increases which we can effectively call as a braking. At the start of braking process the vehicle has a higher speed than the flywheel, giving a certain speed ratio between them whereas at the end of braking the vehicle has a lower speed than the flywheel so the ratio of speeds has changed. [3]

2. **Electrical KERS:**

Electrical kinetic energy recovery system converts the kinetic energy into chemical energy for storage and an electric motor generator system is used as the energy transfer and control media . The common components used in battery storage type kinetic energy recovery system are Electric Propulsion Motor /Generator, Power Electronics –Inverter, and the Quad Flywheel Storage. Capacitors are fundamental electrical circuit elements that store electrical energy in the order of microfarads and helps in filtering . The main function of a capacitor is to get charged and discharged electricity . A super-capacitor is an upgraded version of a capacitor having special features such as long life, rapid charging, low internal resistance, high power density, and simple charging method as compared to capacitors and batteries. [3]

Advantages of Mechanical KERS over Electrical KERS :

- The main difference between them is in the way they convert the energy and how the energy is stored within the vehicle.
- Battery-based electric KERS system required a number of energy conversion each with corresponding efficiency losses.
- The Mechanical KERS system storing energy mechanically in a rotating flywheel eliminates the various energy conversions and provides a global energy conversion efficiency exceeding 70%, more than twice the efficiency of an electric system.[3]

1. **Comparison Analysis:**

The comparison between the conventional bicycle and KERS bicycle considering different parameters is presented in the table below. [4]

SR.No.	Conventional Bicycle	KERS Bicycle
1.	Distance covered less.	Distanced covered more.
2.	Kinetic Energy cannot be stored.	Kinetic energy can be stored.
3.	Normal acceleration.	Extra acceleration due to flywheel.
4.	Speed is reduced only using brakes.	Speed can be reduced using both brakes and clutch.

2. **Advantages: [5]**

1. High Power capability
2. Low weight and small size
3. Long framework life of upto 250,000 kms
4. Low cost and efficient plans

3. **Disavantages:**

Developing this sort of KERS, have detailed that it is greatly hard to create, and won't be very beneficial unless it is placed in the ideal position.

4. **Application**

We can implement the system for bicycle models, exercising equipments, pedaling unit etc.

IV. CONCLUSION

It is found from literature review that the KERS system used in the vehicles satisfies the purpose of saving a part of the energy lost during braking. 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. As now a day's energy conservation is very necessary thing. The KERS system in a bicycle is use with an engaging and disengaging clutch mechanism for gaining much more efficiency. Flywheel can be used instead of battery to store and deliver energy efficiently. As use of flywheel in bicycle is a new concept, this field has a huge scope and wide range of implementation ahead.

V. FOTURE SCOPE

We can add more features like pedaling with flywheel for generating power with dynamo interfacing. Instead of using lever arm servo motors can be used. The flywheel weight can be optimised. Multilayer flywheel can be designed using lighter material at the center and heavier material at the periphery. The design of the flywheel can be optimised. Instead of chain drive efficient belt drive CVT can be used to improve the power transmission.
We can amplify the venture by outlining even with Electric bike display also we can increase the efficiency by using additional sensors.

REFERENCES

[1]. Sreevalsan S Menon, Sooraj M S, Sanjay Mohan, Rino Disney, Suneeth Sukumaran "Design and Analysis of Kinetic Energy Recovery System in Bicycles" - International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 8, August 2013.
[2]. A project report by Shreemoy Kumar Nayak on "Design of Kinetic Energy Recovery System for Bicycle" under the guidance of Prof. S. K. Behera, Department of Mechanical Engineering, National Institute of Technology Rourkela.
[3]. Radhika Kapoor, C. Mallika Parveen, Member, IAENG "Comparative Study on Various KERS"- Proceedings of the World Congress on Engineering 2013 Vol III, WCE 2013, July 3 - 5, 2013.
[4]. Siddharth K. Patil., "Regenerative Braking System in Automobiles", International Journal of Research in Mechanical Engineering &Technology vol.2, pp.45-46,2012.
[5]. D. Mojeswara Rao, CH. Dharma Teja, N. Harshadeep, S.Jagadish Varma, N. Nitin Kumar "Kinetic Energy Recovery System In Bicycle" International Journal ofMechanical Engineering and Technology, Volume 8, Issue 5, May 2017.
[6]. Retrived from: www.autosport.com
[7]. Retrived from: www.bikepanthi.com