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Design and Development of Kinetic Energy Recovery System (KERS) For Utilization of Waste Energy and Electromechanical Speed Governor For Road-Lane Safety

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Abstract – *The term KERS refers to a technology that is used to recover the kinetic energy of any vehicle that is lost while retardation or deceleration. Kinetic Energy Recovery System (KERS) is a system 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. Kinetic Energy Recovery Systems (KERS) is a type of regenerative braking system which has different approaches to store and reuse the lost energy. In case of automobiles, energy conservation can be done by using regenerative braking systems (RBS). When driving an automobile, a great amount of kinetic energy is wasted when brakes are applied, which then makes the start up fairly energy consuming. In case of automobiles, energy conservation can be done by using regenerative braking systems (RBS) by kinetic energy recovery system. So the target of recovering the energy lost in braking is completed under the various types of Kinetic Energy Recovery System (KERS).The vehicle may be built using various KERS designs, based on type of KERS used. An extra feature is added to control the speed of vehicle which is more effective during the change of lane on express highways.*

Key Words: **KERS, Electromechanical Speed Governor, Motor, RBS, Battery, Electric Vehicle**

1. INTRODUCTION

Conventional KERS systems available in the market are converting the loss in kinetic energy of the vehicle into electrical energy and stored in battery for further use. It is important to note that the kinetic energy available as high grade energy (mechanical) is first converted to electrical energy (low grade) and is stored in the battery. This energy is again converted from electrical energy to mechanical energy by use of motor. It is needless to say this conversion process is in-efficient leading to little energy recovery thus making the KERS un-economical and un-viable.

The proposed mechanical to mechanical KERS uses an innovative planetary gear train also the dedicated disk brake system to recover the loss of kinetic energy from the front wheel axle of the vehicle. This energy is stored in a spiral spring set-up controlled by use of a unidirectional sprag clutch. This system is compact, practical and a low cost solution that converts the loss of kinetic energy of vehicle during braking and stores it as mechanical (high grade) energy. It gives minimal loss in transmission there by leading to better efficiency. It has better conversion ratio as compared to any other earlier KERS systems. Electromechanical speed governing system is coupled to the KERS system in an innovative manner such that even if the vehicle tries to overcome the speed limit of the given lane the electromechanical speed governor will activate the KERS thus the vehicle will be retarded to the given speed limit but at the same time kinetic energy will be recovered and saved for further use.

1.1 Problem Statement

1. Existing systems aim at converting basically the kinetic energy of the vehicle into mechanical energy which is further converted into electrical energy by dynamo to be stored into batteries this energy stored in batteries is later reused to accelerate the vehicle using DC motor.

2. Here conversion losses are observed at each stage due to in-efficiency of each component of system –viz, the dynamo, battery and the electric motor. Thus solution on this problem is that there is need of a simpler system that will convert and store the kinetic energy into pure mechanical form and make use of same energy to accelerate the vehicle.

1.2 OBJECTIVES

To design and develop and fabricate mechanical KERS system aided with the support of electromechanical speed governing lane safety system

2.0 Scope of the project

Modify and Design suitable KERS to recover kinetic energy for general private and public vehicles. To develop electromechanical governor system to assure the road lane safety of the vehicle.

3.0 LITERATURE SURVEY

Kinetic Energy Recovery Systems (KERS) by means of Flywheel Energy Storages (FES). KERS by means of FES are currently under development both for motor sport and road hybrid vehicles. The aim of the work is the optimization and implementation to the hybrid and electric road vehicles. Testing equipment for the experimental analysis of the simplified FES was designed. A regenerative brake is a mechanism that reduces vehicle speed by converting some of its kinetic energy into another useful form of energy - electric current, compressed air. This captured energy is then stored for future use or fed back into a power system for use by other vehicles. For example, electrical regenerative brakes in electric railway vehicles feed the generated electricity back into the supply system. In battery electric and hybrid electric vehicles, the energy is stored in a battery or bank of twin layer capacitors for later use. Other forms of energy storage which may be used include compressed air and flywheels. Regenerative braking utilizes the fact that an electric motor can also act as generator.

In comparison with other battery storage technologies, KERS offers:

• Cycle durability - 90% efficiency of flywheel (including power electronics) in both directions during KERS reference duty cycle.

• Extensive operating temperature range.

• High efficiency at whole working speed range.

• No chemistry included, thus no environmental pollution and great recycling.

4.0 CONSTRUCTION

1. Prime mover :

   Prime mover is a single phase AC motor 50 watt power and speed variable from 0 to 6000 rpm.

2. Input open belt drive (V-belt)
3. Sun Gear : Spur gear mounted on the axle.
4. Disk brake with caliper and brake lever.
5. Planet gear mounted on planet pin mounted on disk brake.
6. Recovery ring : Internal spur gear mounted on axle carries the scroll spring.
7. Scroll spring: Spring steel flat spring to be wound with inner side fixed on the recovery ring hub and outer side on the sprag clutch holder.
8. Sprag clutch holder carries the uni-directional sprag clutch and is in initial lock position using the lock-release lever on frame.

The Lane safety by low cost automation system and accident prevention system comprises of the following:

a) Chassis or Frame: The chassis or frame is fabricated structure that carries the entire system, rear wheel shaft is the driver shaft that carries the reduction pulley driven by motor using an open belt drive. The end carries the steering mechanism in form of Ackerman steering with the central steering wheel controls the steering angle using the slotted lever arrangement.

b) Motor: Motor is the prime mover, it is single phase AC motor 50 watt, 0 to 6000 rpm variable speed. Motor speed is regulated using electronic speed regulator.

c) Over speed Sensing mechanism : The over speed sensing mechanism is a mechanical linkage based on the bob-weight type centrifugal governor , only that is used to vary the proximal distance between the probe and the sensor which is inductive type.

d) Electronic Proximity sensor
The electronic proximity sensor is mounted on the sheet metal panel on the base frame by means of a Z shaped clamp. The proximity sensor as the name suggests senses the proximity of the indexer buttons which acts as stops, such that when they come in front of the proximity sensor the table the relay is operated to stop the table motion. The proximity sensor is connected to the electronic relay and the power source.

Sensor type: Inductive type proximity sensor Size: M18

e) Electronic Speed Regulator
Motor is a commutator motor i.e., the current to motor is supplied to motor by means of carbon brushes. The power input to motor is varied by changing the current supply to these brushes by the electronic speed aviator, thereby the speed is also changes

f) Braking Mechanism: The braking mechanism uses a Disk brake and brake caliper arrangement. The Disk brake is used with the view to maximize the braking and ensure safety. The brake caliper is actuated electrically using a solenoid, with electromagnetic operation.

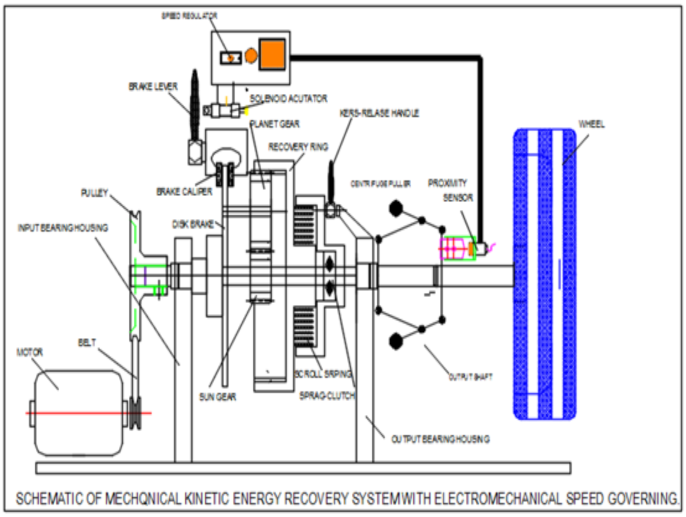

Fig.1 Schematic of mechanical kinetic energy recovery system with electromechanical governing

5.0 Experimental Validation

5.1 Test and Trial on KERS

- **Procedure for Constant Brake Load**

1. Start motor

2. Keep Constant load of 0.45 kg

Calculations for 1st Reading:

Data: Wheel diameter: 31.5 cm

Initial Speed= D*N*0.001885

Where

D=Wheel diameter

N=Speed in rpm

Initial Speed = 220*31.5*0.001885= 13.064436 kmph

Load = 0.45 kg

Output Speed = 160 rpm

=160*31.5*0.001885

Output speed = 9.5004kmph

Initial Kinetic Energy = $\frac{1}{2} mv_i^2$

$= \frac{1}{2} * 0.45 * 13.064436^2$

= 38.7584 J

Final Kinetic Energy = $\frac{1}{2} mv_f^2$

$= \frac{1}{2} * 0.45 * 9.5004^2$

= 20.5003 J

Energy Absorbed = Initial Kinetic Energy (J) - Final Kinetic Energy(J)

= 38.7584 - 20.5003

= 18.2581 J

Brake Torque = Force*Effective radius of disc brake

= 0.45*9.81*0.104

= 0.459 N-m

$$\text{Power Absorbed} = \frac{2*\Pi*N*T}{60}$$

$$= \frac{2*\Pi*160*0.459}{60}$$

= 7.6906 W

At constant breaking load, power output of the system increase with increase in speed.

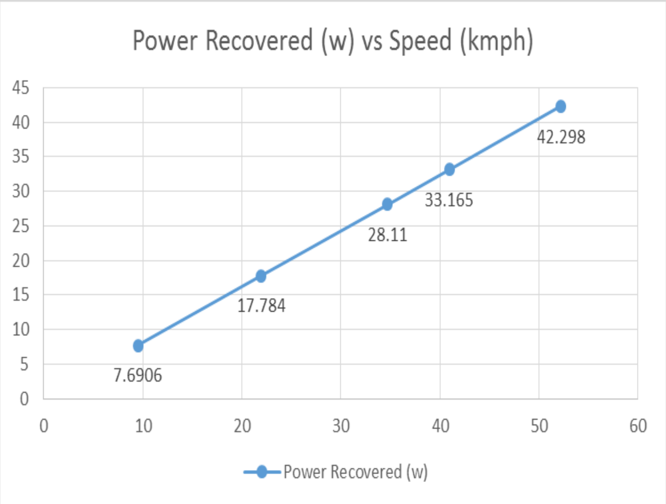

Chart -1: At Constant Braking Load (0.45kg)

6.0 ADVANTAGES

1. Increase of overall energy efficiency of a vehicle.
2. Increases the lifespan of friction braking systems.
3. Cuts down on pollution related to electricity generation.
4. The system eliminates the over-speeding which considerably reduces the chances of accidents due to over-speeding.
5. Ensures safety of the driver and or passengers as automatically speed is reduced.
6. Reduces brake wear and tear as no need of excessive braking force to keep vehicle speed in control.
7. Low system cost as low level electronics is used.
8. Minimal space requirements hence modifications in conventional system is reduced further increases the adaptability of system

7.0 APPLICATIONS

Addition of the system with passenger cars, sports utility vehicle and commercial cars, medium to heavy duty transport vehicles, cargo trucks and public transport vehicles etc.will be economical and ensure the road safety.

8.0 CONCLUSIONS

From design, development and testing of the KERS system it is concluded that the wastage of kinetic energy in the form of friction and heat can be stored for further use and the speed of the vehicle can be controlled by governing system.The increase in speed results into more energy recovered.

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