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Novel Analysis of flywheel based kinetic energy conversion system in a bicycle.

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ABSTRACT **-** A lot of wastage of energy in the existing systems of many conventional consumer products such as blender mixers drills grinders , and at an consideration even bikes and bicycles , it is theorized that the existing designs can be improved a lot in terms of efficiency by the use of flywheels, which acts as key element in the transfer of energy from a motor to the flywheel and then to the required way of application , basically a flywheel is connected toa motor by the means of a gear or belt systems (dependent on the traction required between them both) and then the shaft connected to the flywheel employs the use of a gearbox or transmission to generate the desired speed to torque ratio as per application

Keywords : Kinetic Energy, bicycle, Dog Clutch, Fly Wheel

INTRODUCTION

basically the flywheel takes in rotational energy and outputs rotational energy in a highly efficient and amplified way, and thus the above concept can be applied to any machine that employs the use of rotational mechanisms for its functioning, here we present the concept in more detailed ways for the inspection at a micro level while takinginto account all the necessary elements , supported by diagrams , pre-existing concepts and put them togetherefficiently for practical use .

We selected the above topic so as to see that if an efficient system using flywheels would be applicable in the automobile engineering sector as a means of direct source for transportation application. With the pollution levels rising, and the push for green and renewable energy, we are to adapt the existing systems to be more efficient, we have tried to adapt the overall design process to various other consumer product using rotatory motion, while adapting our calculations and system to them respectively.

LITERATURE REVIEW: - (What systems already exist):

- **[1] Nishad Kumbhojkar , Kunal Mohite , Anand Kulkarni , Sanket Patil** in their research paper "DESIGN AND IMPLEMENTATION OF KINETIC ENERGY RECOVERY SYSTEM (KERS) IN BICYCLE" used the concept of Kinetic energy recovery system , KERS for short , to develop a regenerative breaking system for the cycle , to be able to operate on stored power in the flywheel , by mounting the flywheel onto the cycles body , and connecting the flywheel to a clutch and clutch to the rear wheel of the cycle with direct means of a chain , with the method to charge up the flywheel to a threshold speed by the means of pedaling

- **[2] Mayuresh Bhoir, Danish Shaikh, Anupraj Shirke, Pratik Yadav, Jaslok Pandey**, in their research paper "KERS Bicycle" created a prototype in a crude sense by mounting the flywheel to the real wheel of the bicycle with a in e directional bike hub holding the fly wheel , they also provided a means to recharge the flywheel power by the help of a motor mounted in conjunction to the flywheel , with a frictional wheel mounted to the shaft of the DC motor, the motor may function independently while charging the wheel , or may work in conjunction with cycle being manually peddled

- **[3] Paritha Pratim Bhora, Kaushik Kalita, Sabir Hussain Choudhury, Sultan Ahmed Chowdhury** in their research paper "APPLICATION OF KERS IN BICYCLE: AN INVESTIGATION" again like the previous group mounted a flywheel on a one directional cycle hub (mounted on top of rear wheel), which was connected to the real wheel via a chain and sprocket mechanism, with no means to charge the fly wheel other than pedalling

Parts of the project:

- The proposed system consists of 3 main segments:
  1. Flywheel assembly
  2. Transmission assembly
  3. Output assembly
  4. Battery build (optional)

Flywheel and motor assembly:

The smaller gear mounted on the motor shaft is in mesh with the bigger gear integrated on the edge of the flywheel, it transmits rotational energy to be stored and amplified to be transferred to the transmission box, delivered by the motor, stored and amplified by the flywheel,

The motor selected is a BLDC motor as there are no contact brushes, the motor upon being loaded does not draw additional current, and its rpm is not affected by the heated coils, its RPM can be regulated by the use of a microcontroller or a potentiometer to deliver a PWM signal to the ESC, electronic circuit control

At the centre of the flywheel is the input shaft of the transmission which is responsible of delivering the power in the flywheel to the transmission

All the numerical and design aspects of the components are provided in the later sections

Transmission assembly:

- the transmission assembly consists of 3 shafts and 11 gears; The first shaft is the extended flywheel shaft which is held up in its bearings (of the machine), on the flywheel shaft are mounted the 1st five gears in a decreasing order of size, each consecutive gear having rounded edges, and fewer teeth thanthe previous ones, the gears vary in size, following the gear ratios of (x): (x+0.5), or (x+0.5): (x), which is dependent on whether the gearing is increasing or decreasing. The second shaft consists of the outputshaft which holds the other five gears required for varying the output speed to torque ratio and is againheld up in the bearings (of the machine). The gears mounted on the output shaft are of same dimensionsas that of the flywheel shaft but in reverse order. The 3rd and the final shaft of the transmission assembly is the shifter shaft, which is responsible for holding the shifting gear which is mounted as such in between the flywheel and the output shafts that its ends are always in contact between the gears mounted on the other two shafts; the sliding gear is also equipped with the curved edges. This basic transmission is able to output 5 different speeds , and is able to shift in between gears without the use of a clutch at low to moderate load conditions ; its ability to do so is given by the rounded edges of the gears on both the

shafts that is the input /flywheel shaft and the output shaft , while the rounded edge sliding gear on the shifter shaft moves in between the shafts; if noticed carefully , the pitch circlediameters of all the gears is so selected that the common line between the points of contact with each step gear in the shafts is a straight line , thus while shifting in between gears, while the flywheel maintains constant to near constant speeds , the rounded edges of the gear provide it the ability to switch gears in between operations without the use of a clutch , since the point of contacts in each stepgear are straight , the teeth of gear per step are aligned and thus while shifting the wear and tear of thegears is less due to lack of hard or sharp corners in the gears. The movement of the gears can be controlled by a rack and pinion setup which is fixated at the axis of the sliding gear, thus upon turningthe pinion of the rack the position of the shifting gear can be adjusted to switch I between the gears toget the desired output of speed tot torque ratios on the output shaft. In case of heavy loading conditions,we can use a dog clutch mechanism fitted in the flywheel and output shafts simultaneously where thewhole transmission can be disengaged from the main system, change the gear, and then again engage it into the system, thus resulting in smooth operations

The output assembly:

► the output assembly is very basic and is equipped with mounts which are able to house various tools or joints according to the need of application , it could be a gear , a drill holder , drill chuck , a universal coupling , a sprocket for chains etc. the selection on type of mount/ coupling to be used on the output shaft depends on the need of application and thus is very versatile, this makes the project to be widely applicable on machines that use a rotational motion as the base to do work/ function . the machine finds applications in many consumer products such as mixers, grinders blenders, drills, etc, with an appropriate size of fly wheel we can even apply this concept to bicycles

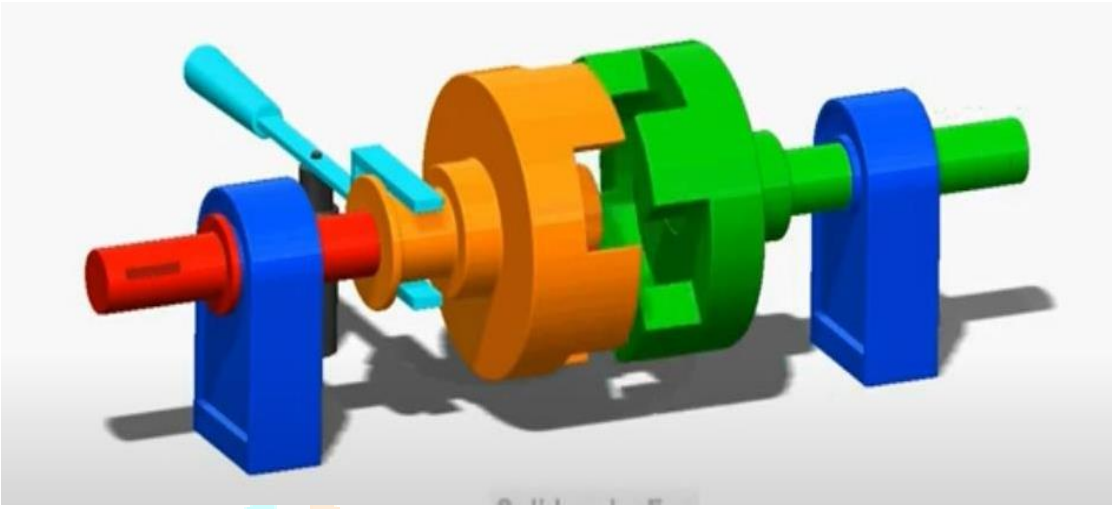
Additional components: battery:

► the battery build is an optional part of the project, where if the designer decides to apply the system to a movable machine, then there should be a source of energy to power the motor, in that case the following battery build is intended to be used:

► we aim to use li-ion cells, which have the capacity of 2600mAh with a peak charge voltage of 4.2 volts, and minimum charge voltage to be usable is 3 volts (even though li-ion cells can sustain up to 2.2 volts of charge, we limit our discharge of cells to 3 volts in order to increase the life span of the battery). The battery would be consisting of multiple cells hence a battery balancing circuit is required, here we use a 6s battery BMS which helps us regulate the charge of the cell within desired constraints, thus having an average output of 24 volts in a 6 series arrangement, with multiple cells connected in parallel usually 3p or 4p i.e., 3 cells in parallel or 4 cells in parallel. There after we use a Buck-Boost converter to regulate the battery voltage and current output which is to be supplied to the ESC circuitof the BLDC motor, since the RPM of the BLDC motor is supposed to be varied upon the voltage supplied, we can obtain different levels of rpm of the motor by varying the input voltage, other than having the control of the potentiometer, or PWM signal as well, thus this increases our versatility of the project

Additional components: dog clutch:

► The dog clutch is supposed to be used in only heavy-duty applications, where the load is so much that, upon shifting the intended transmission of gears with curved edges will cause withering or locking of gears, since heavy loads directly mean more mass of the fly wheel, which will translate to higher rpmsto keep the systems sustained, thus very high speeds among the gears may cause locking while shifting



Dog Clutch

► The dog clutch can be applied at points of load like the segment of input shaft just after fly wheel, of the segment of output shaft just before the load.

Materials used in components:

Materials: we use the commonly suggested materials for the following model to conduct our experiments on, and to check the theoretical aspects of the discussed concept, the following table summarizes the materialsused for the components:

Component	**Material used**
Flywheel	Steel
Shafts	Mild Steel
Gears	Hard Abs Plastic
Bearings	Chrome Steel, Mild Steel
Clutch	Steel

Experimental design of components:

- flywheel: mass ‘m’, width/thickness ‘b’, diameter ‘m’
- shafts: length ‘a’, ’b’, ’c’, diameter ‘d_2’ ‘d_3’
- power adapter: 19 volts, 7 amperes
- BLDC motor: of ‘x’ Kev

- ESC: 'I' ampere
- bearing: of size as per shaft: same as that of shaft diameters

Gears 1,6	**Teeth: 8**	**Diameter: 2 cm**
Gears 2,7	Teeth: 12	Diameter: 3 cm
Gears 3,8	Teeth: 18	Diameter: 4.5 cm
Gears 5,10	Teeth: 40	Diameter:10 cm

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