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Design and Fabrication of Flat Coil Spring Motioning Bicycle

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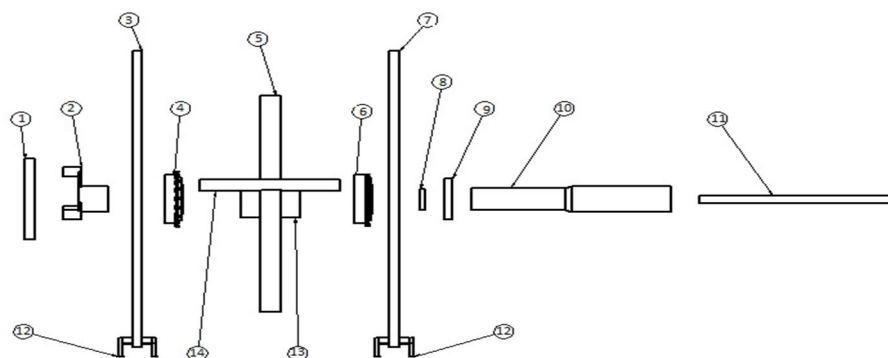
Abstract: There is various type of spring available like helical spring, Flat coil spring, etc., the different energy storage management spring are there, one of the most common type of spring is Flat coil spring. Flat coil spring are also known as spiral torsion, clock spring or brush spring .it is widely used when the small space is available and higher torque is needed. Basically, the spring are made up of harden steel, strain less steel, carbon steel and ferrous (bronze, titanium), even plastics also used. The applications are window regulator, clocks, DC motor, seat recliners, electric switch gear, two wheelers for kick starting. Here the principle used in this project is, the kinematic energy is converted into mechanical energy. In this project the flat coil springs used to increase the speed of the cycle. This coil springs has been load and unload with the help of circular plate and free wheel mechanism. During the unload condition of spiral spring, storage of the spring force has been directly given to the wheel. When spring in load condition, there Is no contact between the wheel and spring. The energy used by the people to travel particular distance in a cycle has been increased twice the amount of initial distance by using our project.

Keywords: Continuous energy looping system (CELS), flat coil spring, free wheel, bearing, epicycloids gear, touch sensor bearing system (TSBS).

I. INTRODUCTION

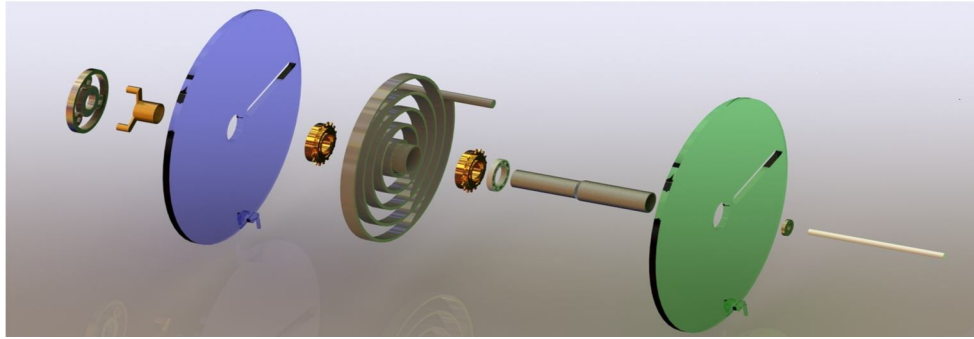
This project has working by continuous energy looping system (CELS). Here the flat coil spring has been used as energy storing and releasing process. The coil spring was covered by two cylindrical plates. Cylindrical plates are near to the wheel which is used to gives the force of the spring to the wheel. The spring's internal end is attached to the hollow cylinder and external end to slot of the circular plate and two free wheels are there, one is attached with the cylindrical plate 1 and another free wheel is attached to the cylindrical plate 2. Where free wheel 1 is in load means free wheel 2 is in unloaded condition, when free wheel 2 is loaded means free wheel 1 is in unloaded condition. When the spring will reach the extreme load level means touch sensor is used there to stop the plate for a fraction of seconds that time will create the spring load to unload condition where the energy of the spring will be transmitted to the wheel that will increase the speed of the vehicle. During that period the free wheel's motion will be interchanged. This setup will bring the increase of speed level to the cycle twice the amount of normal speed level. It has reduced the man working power.

A. Design And Its Explanation



Components of Prototype

1. Epicycloids' Gear, 2.Isolated Hollow Shaft, 3.Loading Plate, 4.Loading Freewheel, 5.flat coil Spring, 6.Unloading Freewheel, 7.Unloading plate, 8.Axle Support Bearing, 9.supporting bearing for wheel hub and frame, 10. Wheel hub, 11.Centre Axle, 12.brake shoe, 13.hollow shaft attached with spring, 14.circular rod .



3D Model of Prototype

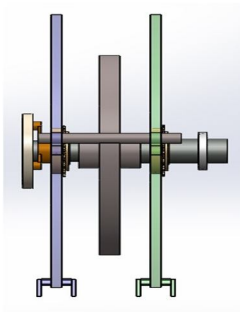


FIG.1

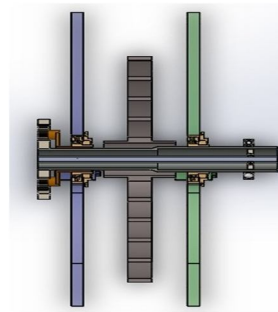


FIG.2

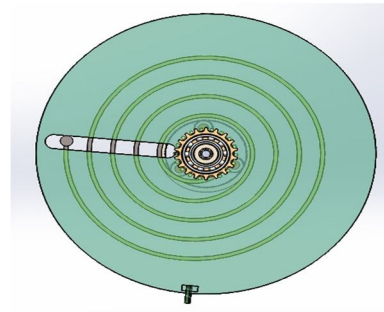


FIG.3

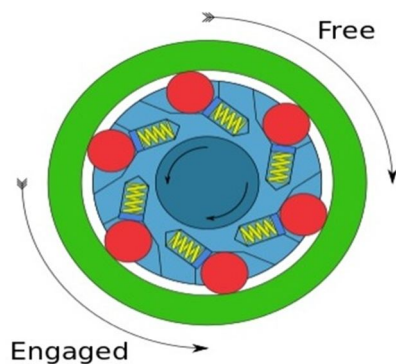
- 1) Prototype 3d front view
- 2) Model cross sectional view
- 3) Prototype 3d left side view

Here the central axis is support to total system. The hollow shaft connected to the wheel hub on one end will revolve along with wheel hub. Hollow shaft on another end connected with epicycloids sun gear and the epicycloids planet gear is connected with a loading plate free wheel and that free wheel is isolated from the wheel hub by using bearing. Here freewheel is connected with loading plate. An unloading plate with same freewheels setup is placed at a few distances from the loading plate as shown in figure in between the two plates the flat coil spring is placed. Braking system is placed at the edge of the plates to apply the brake with the help of sensor bearings are provided to give uninterrupted flow of motion between two parts.

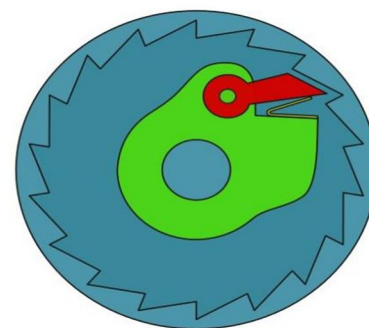
II. MAIN PARTS EXPLANATION

A. Free Wheel

A freewheel is a ratchet mechanism mounted on the rear hub which allows the chain to drive the wheel forward via a cog but when the wheel move faster than the chain the cog is not driven round by the wheel. Simply, freewheel is engaged in forward direction and disengaged in reverse direction as shown in the figure given below.



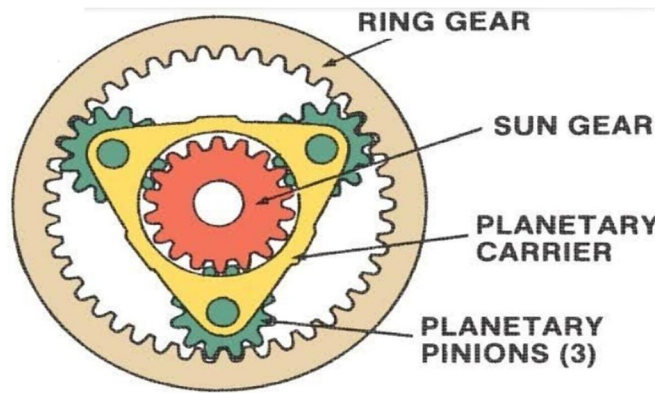
Free Wheel Mechanism



Ratcheting Free Wheel Mechanism

B. Epicycloids Gear

The epicycloids gear consists of sun gear, planet gear and ring gear. The sun gear rotate in forward direction mean, the planet gear will motion in reverse direction when the ring gear is in fixed condition.



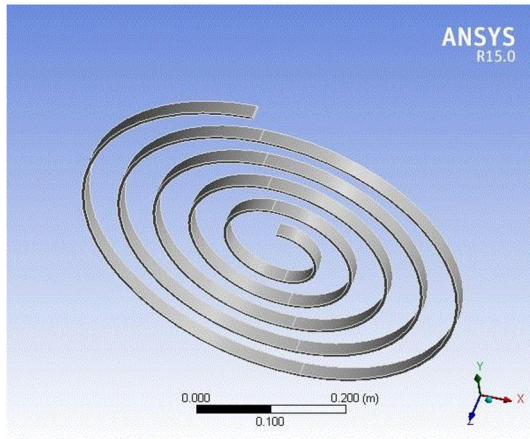
Epicycloids gear

III. ANALYSIS

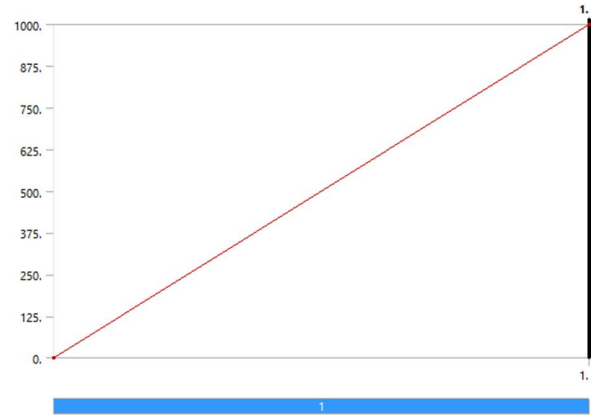
A. Static Structural Analysis

Material properties Of Stainless Steel

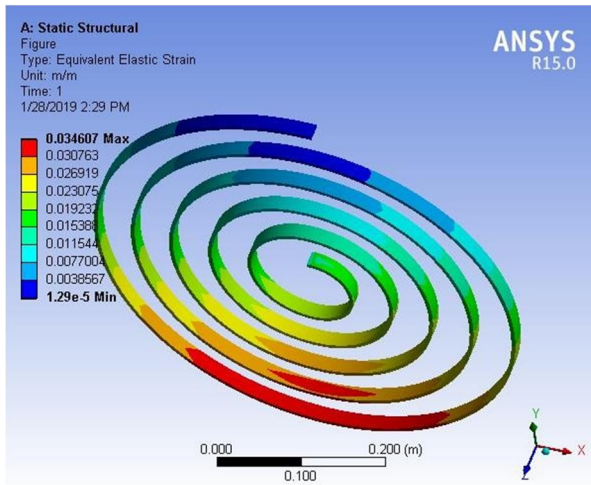
Constants		
Density	7750	Kg m ⁻³
Coefficient of thermal expansion	1.7e ⁻⁰⁰⁵	C ⁻¹
Specific heat	480	J kg ⁻¹ C ⁻¹
Thermal conductivity	15.1	W m ⁻¹ C ⁻¹
Resistivity	7.7e ⁻⁰⁰⁷	Ohm m
Compressive Ultimate Strength	0	Pa
Compressive Yield Strength	2.07e ⁺⁰⁰⁸	Pa
Tensile yield strength	2.07e ⁺⁰⁰⁸	Pa
Tensile ultimate strength	5.86e ⁺⁰⁰⁸	Pa
Isotropic secant coefficient of thermal expansion		
Reference temperature	22	C
Isotropic Elasticity		
Young's modulus	1.93e ⁺⁰¹¹	Pa
Poisson's Ratio	0.31	
Bulk Modulus	1.693e ⁺⁰¹¹	Pa
Shear Modulus	7.3664e ⁺⁰¹⁰	Pa
Isotropic Relative Permeability		
Relative Permeability	1	
General		
Volume	5.101e ⁻⁰⁰⁴	m ³
Mass	3.9533	Kg
Centroid X	-1.6149e ⁻⁰⁰²	m
Centroid Y	1.3252e ⁻⁰⁰²	m
Centroid Z	1.9411e ⁻⁰¹⁸	m
Moment of Inertia Ip1	8.8395e ⁻⁰⁰²	kg.m ²
Moment of Inertia Ip2	7.6221e ⁻⁰⁰²	kg.m ²
Moment of Inertia Ip3	0.16435	kg.m ²



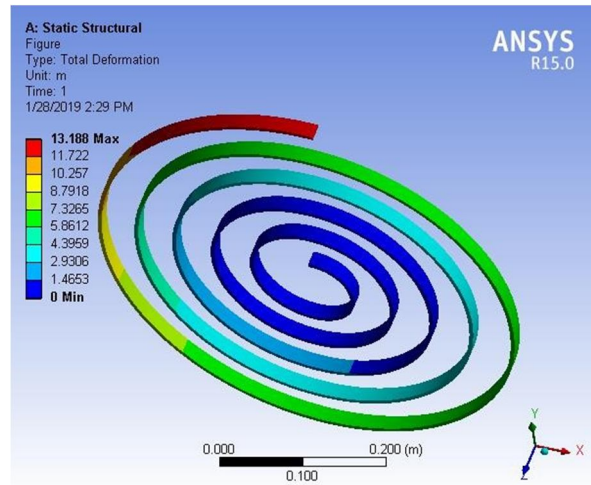
Model To Analysis



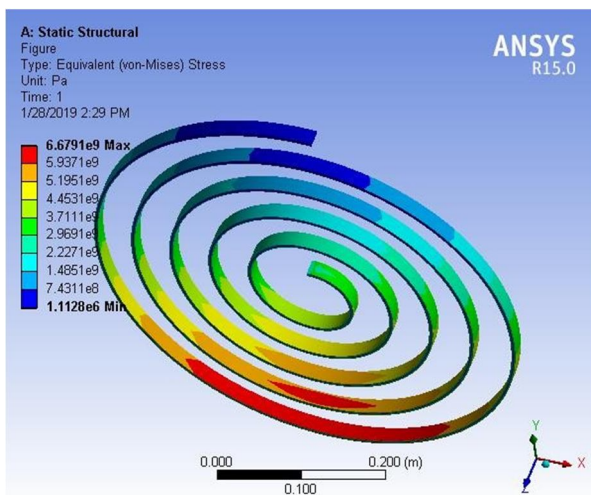
Force Vs Time



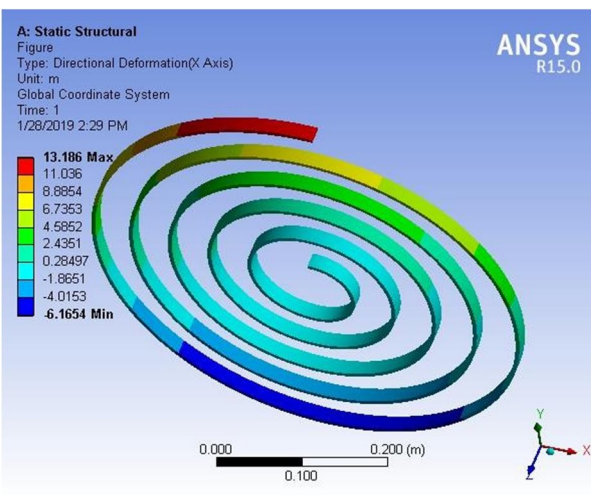
Equivalent Elastic Strain



Total Deformation



Equivalent (Non-Mises) Stress



Directional Deformation X Direction

The spring is analyzed with stainless steel (material) in Ansys 15.0 software. The above figures shows the load acting points, maximum deformation report, equivalent elastic strain report along graph indicating variation of load(1000N) with time(1sec). Here we have used fixed support and force in non suppressed condition. Force is defined by Vector at 1000 N (ramped). 19659 Nodes and 2068 Elements were used to analyze this model. The model spring is analyzed to get result at Equivalent Elastic Strain, Total Deformation, Equivalent (Non-Mises) Stress and Directional Deformation X Direction.

B. Working Mechanism

The wheel hub (10) is attached to the rear wheel of the bicycle and it will continuously run when the wheel runs, and stop when the wheel stops. The unloading plate (12) which is nearer to the wheel used to give the force of the spring connected to the wheel. The spring's (5) internal end is attached to the hollow cylinder and, the external end is attached to slot of the unloading plate (7) and loading plate (3).

When the epicycloids' sun gear (1) coordinates with the wheel hub (10) with strong connection, where the planet gear and ring gear will rotate in reverse motion of the sun gear, from this reverse motion the load will be created on spiral spring (5).

Initially, we will run the cycle by pedaling and, the spring will be loaded after pedaling. During the planet gear's reverse motion, the spring (5) has been loaded and the circular rod (14) is sliding to the bottom of the slot. When the circular rod (14) is in bottom of the slot, the brake (12) where activated. After this free wheel mechanism is used to unload the spring in unloading plate (7) which is nearer to wheel, and the circular rod (14) is moving to the top of the slot. When the circular rod (14) is reached to the top of the slot and touch the touch sensor, then the brakes where activated by the touch sensor signal, then the unloading plate (7) has been stopped and, the loading plate (3) has been energized by the planet gears reverse motion and it will have used to load the spring (5) again.

And this is a system which is continuously running system. And the bicycle need to stop at various disturbances like speed brakes, etc., the cylindrical plates where locked by the same sensor braking system. In this system the full setup was in control and it will also provide the safety ride for the riders.

C. Calculation

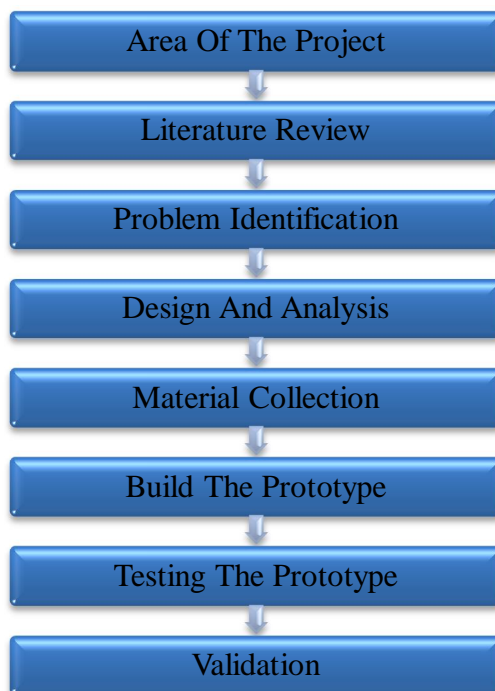
$$\text{Length of the spring} = P(\Theta_0^2 - \Theta_1^2)/4\Pi =$$

Where,

$$\Theta_0 = 2 \Pi r_o, r_o - \text{number of turns of inner end of the spring.}$$

$$\Theta_1 = 2 \Pi r_i, r_i - \text{number of turns of outer end of the spring.}$$

IV. METHODOLOGY



A. Specification

Center axis	
Length	: 200mm
Diameter	: 10mm

Hollow shaft	
Inner diameter	: 35mm
Outer diameter	: 30mm

Plate	
Diameter	: 400mm
Center hole	: 50mm
Slot diameter	: 20mm
Allowance	: 20mm
Plate thickness	: 10mm

Bearing	
Inner diameter	: 10mm
Outer diameter	: 20mm
Width	: 8mm

Spring	
Diameter	: 330mm
Thickness	: 5mm
Width	: 20mm
Hollow shaft	: 50mm
Rod Diameter	: 10mm
Length	: 2264mm

Isolated shaft (hub)	
Inner diameter	: 31mm
Outer diameter	: 35mm
Length	: 30mm

Bearing (2)	
Inner diameter	: 36mm
Outer diameter	: 56mm
Width	: 8mm

B. Component Function

COMPONENT	LOADING OF SPRING	UNLOADING OF SPRING
spring	Moving to bottom of slot	Moving to top of slot
Free wheel in plate 1	Free motion	Existing of motion
Free wheel in plate 2	Existing of motion	Free motion
Plant gears	Force will give to spring	Force will not give to spring
Sun gear	Force will give to planet gear	Force will give to planet gear

C. Motion Direction Of Components

COMPONENTS	LOADING	UNLOADING
cameral axle	idle	idle
hollow shaft	clockwise	clockwise
epicycloids sun gear	clockwise	clockwise
planetary gear	anticlockwise	anticlockwise
ring gear	idle	idle
isolated hollow shaft	anticlockwise	anticlockwise
loading freewheel	anticlockwise	idle
unloading freewheel	idle	clockwise
loading plate	anticlockwise	clockwise
unloading plate	anticlockwise	clockwise
spring	anticlockwise	clockwise
cycle rear wheel	clockwise	clockwise

D. Advantage

- 1) To reduce the vehicle pollution in environment and to increase eco-friendly system.
- 2) In our future there would be no fossil fuel to operate transport vehicle and fuel related applications, so this system will help to operate many automation systems.

E. Future Scope

This mechanism is added to front wheel to increase the efficiency (when front wheel's spring loading the rear wheel spring unloads).

V. CONCLUSION

In older days Bicycles are used to long travelling transport vehicle from one place to another place. But currently for long travel there are many vehicles are available. But comparing with other vehicle bicycle is a pollution free vehicle and it will be good for human health also. So in this project the cycle has been used and the same time it will be run faster compares to normal bicycle. Here we are using a flat coil spring which can store the energy and release it to increase the speed of the cycle. As same as the coil spring has fixed in the cycle and tested. The test shows that the cycle travelling distance has increased $1\frac{1}{4}$ the amount of normal running distance and also the braking system works properly. This project justify that the travel distance of the cycle has increased by using this flat coil spring.

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