Design and Analysis of Fulcrum Cycle

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Abstract— Conventional bicycle is exhaustive for long drives as it causes fatigue to the knees. To overcome this there is advancement in cycle technology leading to fulcrum bicycle. This bicycle works on the lever principle instead of conventional circular pedalling. The cycle has the same sprocket and chain mechanism but a slight difference in the process of actuation. Lever principle provides mechanical advantage which helps in reducing the fatigue caused by conventional cycling. One end of the lever is connected to the pedal whereas the other end is connected to two binary links. The primary link undergoes slight oscillations providing rotary motion to the secondary link which rotates the axis shaft of the sprocket. Conventional cycle has the pedals attached to the secondary link. The lever length and the length of primary link can be changed in accordance to the convenience needed by the rider.

Keywords: Fulcrum Cycle

I. INTRODUCTION

A bicycle, also called a cycle or bike, is a human-powered, pedal-driven, single-track vehicle, having two wheels attached to a frame, one behind the other. A bicycle rider is called a cyclist, or bicyclist. Bicycles were introduced in the late 19th century in Europe, and by the early 21st century, more than 1 billion have been produced worldwide. These numbers far exceed the number of cars, both in total and ranked by the number of individual models produced. They are the principal means of transportation in many regions. They also provide a popular form of recreation, and have been adapted for use as children's toys, general fitness, military and police applications, courier services, bicycle racing and bicycle stunts.

The bicycle is only one of the many man-developed lever systems for land transport, but it is the sole remaining type that has a limited propulsive power. Millions of people around the world still rely on their trusty clunkers for cheap and efficient transportation. In fact, the global fleet approaches a billion, with the vast majority circulating in developing countries like Cuba and China where automobiles remain a luxury. Recreational riders continue to take to their wheels for exercise, adventure, and companionship. The Lever Driven Bicycle consists of the following parts: mounting plate, torsion spring and oscillating lever. The lever is pivoted at a point on the mounting plate which is fixed to the bicycle frame and a torsion spring is present in between the mounting plate and the lever. The end of the lever contains a gear sector which is in mesh with the free wheel. This changes the existing conventional driving mechanism by the oscillating motion of a lever into rotatory motion of the wheel. The downward motion of the lever is powered by the human leg objectives of this project work is to reduce the effort which is required for cycling and provides a means of transportation to peoples with small disability to his or her legs (i.e. a person with a leg shorter than the other), reduced maintenance which is regularly required for a conventional bicycle (lubrication and tightening of the chain, freewheel and crank set), provides a way of transportation by applying effort only on a single lever and a new way for cycling to the cycling enthusiasts and the return or the upward movement of the lever is achieved by the use of torsion spring. The main
The idea of making a Fulcrum Bicycle with an innovative pedaling system has been shaped in the form of our project. We have sought to make an invention in a true sense. Many features of Fulcrum Bicycle are unique. The Fulcrum Bicycle will be proving as one of the best personnel transportation vehicle for a shorter distance as well as the best exercise bike. The pedals are activated by human power in an alternate oscillo-rotational movement. The bicycle also is constructed with a seat which allows for restful pedaling and support. Hence, making it a comfortable mode of transportation.

Conventional bicycle is exhaustive for long drives as it causes fatigue to the knees. To overcome this there is advancement in cycle technology leading to fulcrum bicycle. This bicycle works on the lever principle instead of conventional circular pedalling. The cycle has the same sprocket and chain mechanism but a slight difference in the process of actuation. Lever principle provides mechanical advantage which helps in reducing the fatigue caused by conventional cycling. One end of the lever is connected to the pedal whereas the other end is connected to two binary links. The primary link undergoes slight oscillations providing rotary motion to the secondary link which rotates the axis shaft of the sprocket. Conventional cycle has the pedals attached to the secondary link. The lever length and the length of primary link can be changed in accordance to the convenience needed by the rider.

The construction of Fulcrum Bicycle as shown in Fig.1. is such that it can be used by all aged groups. It can also be used as an exercise bike. The motion of pedals and the position of seating are in proper ergonomics. During the use of this cycle the ligaments are not stressed only the muscles are strained, proving it as an exercise bike. It will be proving as a weight loosing machine for weight persons. Since the ligaments are not strained, those having knee bending problems can use this cycle as a best option for transportation and exercise. Hence this Fulcrum Bicycle will be proving its medical importance.

II. PROBLEM STATEMENT

Lower back pain is common in cyclists since they use their lower backs to control and power the bike. The stress added onto the back may produce chronic pain. Bike riders may also suffer a variety of injuries to the tendons or muscles in the knee areas. In some of these cases, it may be necessary to see a doctor or physiotherapist. Conventional bicycle is exhaustive for long drives as it causes fatigue to the knees. To overcome this there is advancement in cycle technology leading to fulcrum bicycle.

A. Objective

1) The main objective of this project is to modify the existing drive mechanism of a bicycle so as to reduce the effort which is required for the driving of a conventional bicycle. This can be achieved by modifying the existing drive mechanism of our conventional bicycle by removing the chain drive and attaching an oscillating lever pivoted at a point on the bicycle frame as discussed below and providing a gear sector at the end of the lever. The lever oscillates by an effort on the other end of the lever by human legs. Similarly there is another lever at the other side of the bicycle frame.
2) The next objective of this project is to provide a means of transportation on the bicycle to a person with a small disability to his or her legs (i.e. a person with a leg shorter than the other). Thus by using the Lever Driven Bicycle the person with the disability will not have to extent his legs for the complete rotation of the crank set for motion. He just only requires oscillating the lever with his legs up to his ability.
3) The other objective of this project is the reduction of the maintenance which is regularly required for a conventional bicycle (lubrication and tightening of the chain, eliminates lubrication and replacement of the ball bearing in the crank set due to wearing while pedalling).
4) Also it provides a way of transportation by applying effort on only a single lever.

It also provides a new way for cycling to the cycling enthusiasts.

B. Overview

Vehicles for human transport that have two wheels and require balancing by the rider date back to the early 19th century. The first means of transport making use of two wheels arranged consecutively, and thus the archetype of the bicycle, was the German draisine dating back to 1817. The term bicycle was coined in France in the 1860s.

The 21st century has seen a continued application of technology to bicycles: in designing them, building them, and using them. Bicycle frames and components continue to get lighter and more aerodynamic without sacrificing strength largely through the use of computer aided design, finite element analysis, and computational fluid dynamics. Recent discoveries about bicycle stability have been facilitated by computer simulations.[48] Once designed, new technology is applied to manufacturing such as hydro forming and automated carbon fibre layup. Finally, electronic gadgetry has expanded from just cyclo computers to now include cycling power meters and electronic gear-shifting systems.

C. Hybrid and Commuter Bicycles

In recent years, bicycle designs have trended towards increased specialization, as the number of casual, recreational and commuter cyclists has grown. For these groups, the industry responded with the hybrid bicycle, sometimes marketed as a city bike, cross bike, or commuter bike. Hybrid bicycles combine elements of road racing and mountain bikes, though the term is applied to a wide variety of bicycle types. Hybrid bicycles and commuter bicycles can range from fast and light racing-type bicycles with flat bars and other minimal concessions to casual use, to wider-tired bikes designed for primarily for comfort, load-carrying, and increased versatility over a range of different road surfaces. Enclosed hub gears have become popular again - now with up to 8, 11 or 14 gears - for such bicycles due to ease of maintenance and improved technology.

A treadle is a part of a machine which is operated by the foot to produce reciprocating or rotary motion in a machine such as a weaving loom or grinder. Treadles can also be used to power water pumps, or to turn wood lathes. In the past, treadles have been used to power a range of machines including sewing machines, looms, wood saws, cylinder phonographs and metal lathes. Along with cranks, treadmills, and tread wheels, they allowed human and animal power of machinery in the absence of electric machinery.

There were bicycles in the past which worked on the treadle mechanism. In order to construct the treadle mechanism we had to study the treadle bicycle. A treadle bicycle is a bicycle powered by a treadle instead of the more common crank. Treadles were one of the mechanisms inventors tried in order to position the pedals away from the drive wheel hub before the development of the bicycle chain or instead of it. Treadles have also been used to drive tricycles and quadra cycles.

Treadles were used before the advent of high wheelers on Thomas McCall's velocipede, on high wheelers themselves in an to attempt to address safety issues, on alternative configurations of high wheelers, and on the first device called a safety bicycle by British engineer Henry J. Lawson in 1876. Some inventors even combined treadles and chains on the same bicycle.

III. FULCRUM LEVER MECHANISM

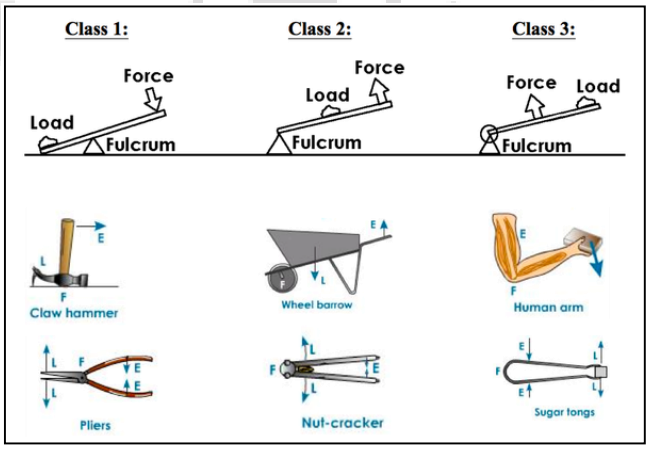

Fig. 1: Table of Fulcrum Lever Mechanism

A. Design of Manual Power train

It's the system which makes the vehicle move. Since the oscillo-rotational pedalling system is an innovative pedalling system, it is needed to be designed with precision. The treadle mechanism is the best suited mechanism for our pedaling system. Instead of conventional treadle mechanism we decided to use crank which was most suitable.

The basic design of manual powertrain consists of:

- The crank shaft
- The crank shaft bearing housing
- The chain ring

- The pin for lever at an offset from the center of the chain ring
- The levers
- The pedals
- The shaft for pedal rotation.

After deciding the basic components of the system Fig.2, Fig.3, Fig.4, it was necessary to decide the dimensions of those components and draw the diagram of the movements of those linkages. The diagram below shows the movement of the components at various positions and gives the appropriate dimensions of the components.

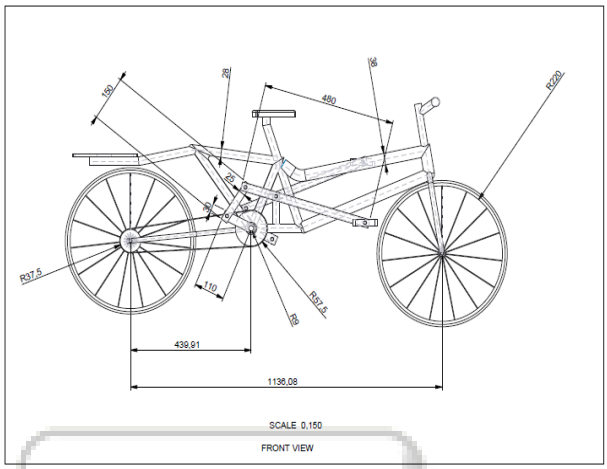

Fig. 2: Schematic diagram 2D model side view

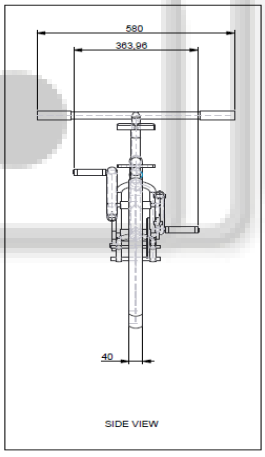

Fig. 3: 2D diagram front view

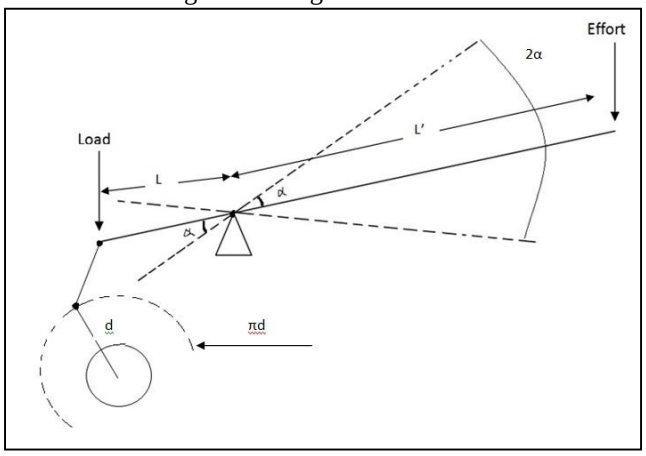

Fig. 4: 2D model of project Fulcrum lever

IV. General Formula

1) Concept of fulcrum- lever mechanism

$$P \times a = W \times b$$

$$W/P = a/b$$

2) Torque on fulcrum:
Torque = Force x distance to fulcrum x sin Θ

3) Torsional shear stress acting on shaft:

$$T = \pi . \sigma_s . d^3$$

V. Conclusion

Fuel saving - People often use vehicle for travelling over short distance. This causes unnecessary wastage of fuel. Due to use of treadmill bicycle over short distance a large amount of fuel can be saved.

Travelling - Fulcrum bicycle can be used for travelling over short distances. One can also exercise while travelling over short distance. Eco- friendly fulcrum bicycle does not require any fuel. Therefore it does not emit any pollutants. So it is an eco-friendly vehicle.

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