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Design and Fabrication of Chainless Bicycle

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Abstract: ***Today's life we meet number of difficulties in transportation. There are number of drives to transmit the power. We have concentrated on bicycle where the efforts while peddling is not efficiently turned to work. In bicycle chain drive is used. Due to the chain drive there is loss of power in transmission. So our idea is to replace chain drive by kinematic links for higher transmission.***

This project is developed for the users to rotate the back wheel of a bicycle using kinematic links. Power transmission through chain drive is the oldest and widest used method in case of bicycle. In this paper we implemented the chain less transmission to the bicycle to overcome the various disadvantages of chain drive.

Recently, due to advancements in kinematic link technology, a small number of modern link-driven bicycles have been introduced. Usually in bicycle, chain and sprocket method is used to drive the back wheel. The link drive only needs in small amount of lubrication using a grease to keep the links running quiet and smooth. A link drive bicycle is a bicycle that uses a link drive instead of a chain which contain four set of link at both the ends to make a new kind of transmission system for bicycle for getting high reliability system, and more safe system.

Link-driven bicycle have used four bar mechanism where a conventional bicycle connected in one end pedal link and another connected in wheel.

This pedal link actuate to drive a wheel. The use pedals to be actuate in 45 degrees wheels can rotating at 180 degrees. According to the direction of motion of pedal, the wheel will be moved forward. This avoids the usage of chain and sprocket method. This "chinless" drive system provides smooth quite and efficient transfer of energy from the pedals to the rear wheel. It is attractive in look compare with chain driven bicycle.

Keywords: Chainless bicycle, four bar mechanism, kinematic link technology.

I. INTRODUCTION

In order to increase the power transmission in bicycle and higher speed the following setup was designed and fabricated. It will increase the efficiency of torque transmitted. 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 kinematic link driven bicycle has a drive link which replaces a chain drive to transmit power from the pedals to the wheel. The arrangement for link driven bicycle as shown fig.1.

Recently, due to advancements in kinematic link technology, a small number of modern link-driven bicycles have been introduced. Link-driven bicycle have uses four bar mechanism where a conventional bicycle connected in one end pedal link and another connected in wheel. This pedal link actuate to drive a wheel.

The use of pedal link to be actuated at up and down 45 degree wheel can rotate 180 degrees due to four bar mechanism. The design of kinematic link produces less vibration and less noise than conventional straight cut gear.

A. Literature Riview

1) *21ST Century:* 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. Once designed, new technology is applied to manufacturing such as hydroforming and automated carbon fiber layup. Finally, electronic gadgetry has expanded from just cyclocomputers to now include cycling power meters and electronic gear-shifting systems.

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B. Main Article: Recumbent Bicycle

2008 Nazca Fuego short wheelbase recumbent with 20" front wheel and 26" rear wheel. In 1934, the Union Cycliste Internationale banned recumbent bicycles from all forms of officially sanctioned racing, at the behest of the conventional bicycle industry, after relatively little-known Francis Faure beat world champion Henri Lemoine and broke Oscar Egg's hour record by half a mile while riding Mochet's Velocar. Some authors assert that this resulted in the stagnation of the upright racing bike's frame geometry which has remained essentially unchanged for 70 years. This stagnation finally started to reverse with the formation of the International Human Powered Vehicle Association which holds races for "banned" classes of bicycle. Sam Whittingham set a human powered speed record of 132 km/h (82 mph) on level ground in a faired recumbent streamliner in 2009 at Battle Mountain. While historically most bike frames have been steel, recent designs, particularly of high-end racing bikes, have made extensive use of carbon and aluminum frames.

Recent years have also seen a resurgence of interest in balloon tire cruiser bicycles for their low-tech comfort, reliability, and style.[citation needed] In addition to influences derived from the evolution of American bicycling trends, European, Asian and African cyclists have also continued to use traditional roadster bicycles, as their rugged design, enclosed chainguards, and dependable hub gearing make them ideal for commuting and utility cycling duty

C. Cross Bicycle

Cross bicycles utilize a road bicycle frame similar to a racing or sport/touring bicycle, and are normally equipped with nearly flat handlebars to provide a more upright riding position than a racing or sport/touring bicycle. As a hybrid bicycle intended for general recreational and utility use, the cross bicycle differs from the cyclo-cross bicycle, which is a racing bicycle purposely designed to compete in the sport of cyclo-cross competition. Cross bicycles are fitted with 700c (ISO 622) wheels using somewhat wider semi-treaded tires (1.125–1.25 in or 28.6–31.8 mm) than those fitted to most racing or sport/touring models.[1] The additional tire width and tread is intended to give the cross bicycle hybrid some ability to deal with rough or littered surfaces that might be encountered on paved or unpaved bicycle trails, such as gravel, leaves, hard-packed sand, and shallow mud. Most cross bicycles are biased towards moderate off-pavement use and light weight, and as such are not normally fitted with fenders, lights, or carrier racks. The larger 700c wheels are a little faster on paved surfaces and can give an advantage for longer trips or for touring purposes.

D. Commuter Bicycle

The commuter bicycle is a hybrid designed specifically for commuting over short or long distances. It typically features derailleur gearing, 700c wheels with fairly light 1.125 inch (28 mm) tires, a carrier rack, full fenders, and a frame with suitable mounting points for attachment of various load-carrying baskets or panniers. It sometimes, though not always, has an enclosed chainguard to allow a rider to pedal the bicycle in long pants without entangling them in the chain. A well-equipped commuter bicycle typically features front and rear lights for use in the early morning or late evening hours encountered at the start or end of a business day.

E. City Bicycle

The 2005 Giant Innova is an example of a typical 700c hybrid city bicycle. Similar to the commuter bicycle, the city bicycle is more optimized for urban commuting. Unlike the European city bicycle, it has mountain bicycle heritage, gearing, and strong yet lightweight frame construction. It usually features mountain bicycle-sized 26-inch (ISO 559) wheels, a more upright seating position, and "middleweight" 1.5–1.95-inch (38–50 mm) heavy belted tires designed to withstand road hazards commonly found in the city, such as broken glass. Using a sturdy welded chromoly or aluminium frame derived from the mountain bicycle, the city bicycle is more capable at handling urban hazards such as deep potholes, drainage grates, and jumps off city curbs. City bicycles are designed to have reasonably quick, yet solid and predictable handling, and are normally fitted with full fenders for use in all weather conditions. A few city bicycles may have enclosed chainguards, others may have suspension forks, similar to mountain bicycles. City bicycles may also come with front and rear lighting systems for use at night or in bad weather.

F. Roadstar Bicycles

Another subclass of the hybrid category is the comfort bicycle. Comfort bicycles are essentially modern versions of the old roadster and sports roadster bicycle, though modern comfort bicycles are often equipped with derailleur gears rather than hub gears. They typically have a modified mountain bicycle frame with a tall head tube to provide an upright riding position, 26-inch (ISO 559) or 28 -inch (ISO 622) wheels, and 1.75-or-1.95-inch (44 or 50 mm) "middleweight" smooth or semi-slick tires. Comfort bicycles typically incorporate such features as front suspension forks, seat post suspension with wide plush saddles, and drop-center, angled North Road-style handlebars designed for easy reach while riding in an upright position.

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G. Hybrid Bicycles

Hybrid bicycles blend characteristics from more specialized road bicycles, touring bicycles and mountain bicycles. The resulting "hybrid" is a general-purpose bicycle that can tolerate a wide range of riding conditions and applications. Their stability, comfort and ease of use make them popular with novice cyclists, casual riders, commuters, and children.

II. METHODOLOGY

A. Problems Of Chain Driven Bicycles

1) Lubrication is critical - unlubricated drives can wear 300 times faster than lubricated drives (difficult to properly re-lube chain).
2) The lubrication attracts dirt which leads to wear problems.
3) Life is usually low since an estimated 90-95% of chain drives are improperly lubricated.
4) Frequent maintenance is required due to wear and stretch.
5) Necessary lubrication is messy (may be a problem in food/beverage industry).
6) Alignment is important as it affects life and stability.
7) Chain drives are noisy (proportional to speed) due to metal-to-metal contact.
8) Linear speed is limited to 3000 ft./min. for roller chain.
9) Vertical drives may present problems since less slack can be permitted than in a horizontal drive in order to insure proper chain/sprocket engagement.
10) Vertical "shaft" drives are generally discouraged.
11) Equipment damage can result upon chain failure due to steel construction.
12) Available only in full box length increments except in rare cases.
13) Smooth speed transfer is not possible due to chordal action.

B. Kinematics

Kinematics is a branch of classical mechanics that describes the motion of points, bodies (objects), and systems of bodies (groups of objects) without considering the mass of each or the forces that caused the motion. ... The study of how forces act on masses falls within kinetics.

Each part of a machine, which moves relative to some other part, is known as a kinematic link (or simply link) or element. ... In mechanical engineering, a kinematic chain is an assembly of rigid bodies connected by joints to provide constrained (or desired) motion that is the mathematical model for a mechanical system.

C. Kinematic Link

Each resistant body in a machine which moves relative to another resistant body is called Kinematic link or element. A resistant body is one which does not go under deformation while transmitting the force.

In mechanical engineering, a kinematic chain is an assembly of rigid bodies connected by joints to provide constrained (or desired) motion that is the mathematical model for a mechanical system. As in the familiar use of the word chain, the rigid bodies, or links, are constrained by their connections to other links

D. Kinematic Inversion

Kinematic inversion is the process of fixing different links in a kinematic chain (or assuming any one of the links, other than the fixed link as fixed)

1) *Inversions of Mechanism:* A mechanism is one in which one of the links of a kinematic chain is fixed. Different mechanisms can be obtained by fixing different links of the same kinematic chain. These are called as inversions of the mechanism. By changing the fixed link, the number of mechanisms which can be obtained is equal to the number of links. Excepting the original mechanism, all other mechanisms will be known as inversions of original mechanism. The inversion of a mechanism does not change the motion of its links relative to each other.

E. Characteristics Of Link

1) Should have relative motion
2) Must be a resistant body.

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Types of Links

- *Rigid:* It undergoes no deformation; Example: crank, connecting rod.
- *Flexible:* Partial deformation; Example: springs, links, ropes.
- *Fluid:* Motion is transmitted by this link by deformation.

F. Construction Of Chainless Bicycle

The chainless bicycle consists of many components some of them are listed below:

- A bicycle
- Four links
- Nuts& Bolts

The chainless bicycle is one of the innovative ideas which is used for reducing human effort. The project requirements are listed above the mechanism involved in this project is the four bar link mechanism. The details of the each and every components is explained in the upcoming paragraph with an detailed explanation as follows

1) *Links:* Links or otherwise called elements. It is the name given to any body which has motion relative to another. All the materials have elasticity. A rigid link is one which deformations are small that they can neglected in determining motion parameters of the links. part of a machine that moves relative to some other part is known as a link. A link or elements is need not to be said to be a rigid body

a) *Link 1 Fixed:* A fixed link is defined as a rigid membrane linked with a master node, to which slave nodes with a selected set of degrees of freedom are attached. (To achieve full rigidity, all degrees of freedom for the slave nodes should be selected.)

b) *Link 2 Reciprocates:* It cause to move alternately backward and forward

c) *Link 3 Oscillates:* Oscillation is the repetitive variation, typically in time, of some measure about a central value or between two or more different states.

d) *Link 4 Rotates:* The equivalent variables for rotation are angular displacement (angle, for short); angular velocity , and angular acceleration . ... It is helpful to recognize the parallel between straight-line motion and rotational motion

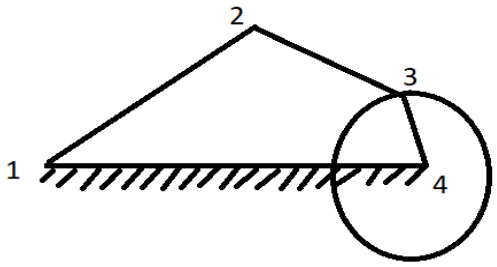


Fig 2.2: diagrammatic representation chainless bicycle

Where:
Link (1 to 2): Reciprocating motion
Link (2 to 3): Oscillating motion
Link (3 to 4): Rotating motion
Link (4 to 1): Fixed

G. Working

The project works under the principle of four bar mechanism. The project works under the links each link has an separate working. The working of the links are

1) Link 1 fixed
2) Link 2 reciprocates
3) Link 3 oscillates
4) Link 4 rotates

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When the pedals gets a force the links starts to work starting from the link 1 to link 4. The pedal gets actuated the link 2 starts to reciprocates. The link 3 gets the oscillatory motion and finally the link 4 tend to rotate. The link 4 is connected with the wheel whereas the link 1 is fixed with the pedal.

The pedal is being welded with the links the pedal gets only 45 degrees of motion. Which makes the cycle to be more effective. The force is applied only in 45 degrees so that the wheels gets full 360 degrees of rotation. Since there is no freewheel attachment in this project it also makes an additional advantages that is when the pedalling gets stopped the wheel rotation also stopped. For an extra safety we have additionally included brakes for an additional safety for the reducing of risk and nervesnous for the new ones who is riding this type of cycle for the first time.

H. Final Project Photos

I. Wireframe Layout

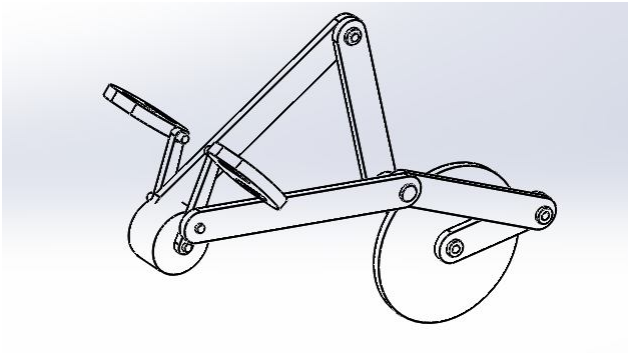


Fig2.3 Wireframe model

J. Three Dimensional Model

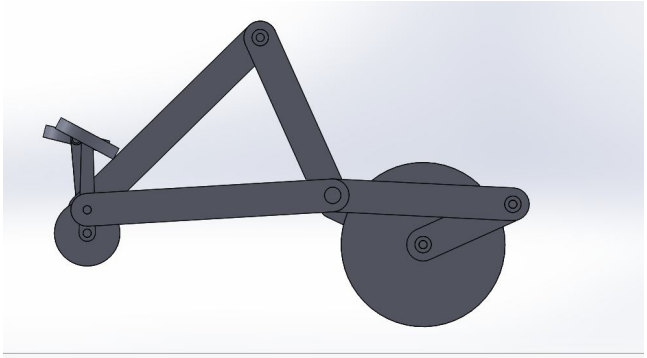


Fig2.4 Three dimensional model

K. Realistic Image Of The Cycle



Fig2.5 Project completed layout

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1) Advantages Of The Chainless Bicycle

a) Less power required.
b) Pedal operated only in 45 degrees.
c) Aerobic exercise.
d) Make system more reliable
e) Increases durability of bicycle.
f) Reduce maintenance cost of the bicycle
g) The chances of slip occurrences is less.

2) Limitations

a) Links can't be lengthened/shortened as chains can, making it difficult.
b) Links are less efficient than chains.
c) Suitable for a single person only.
d) Links can't be made as narrow as chains.

III. CONCLUSION

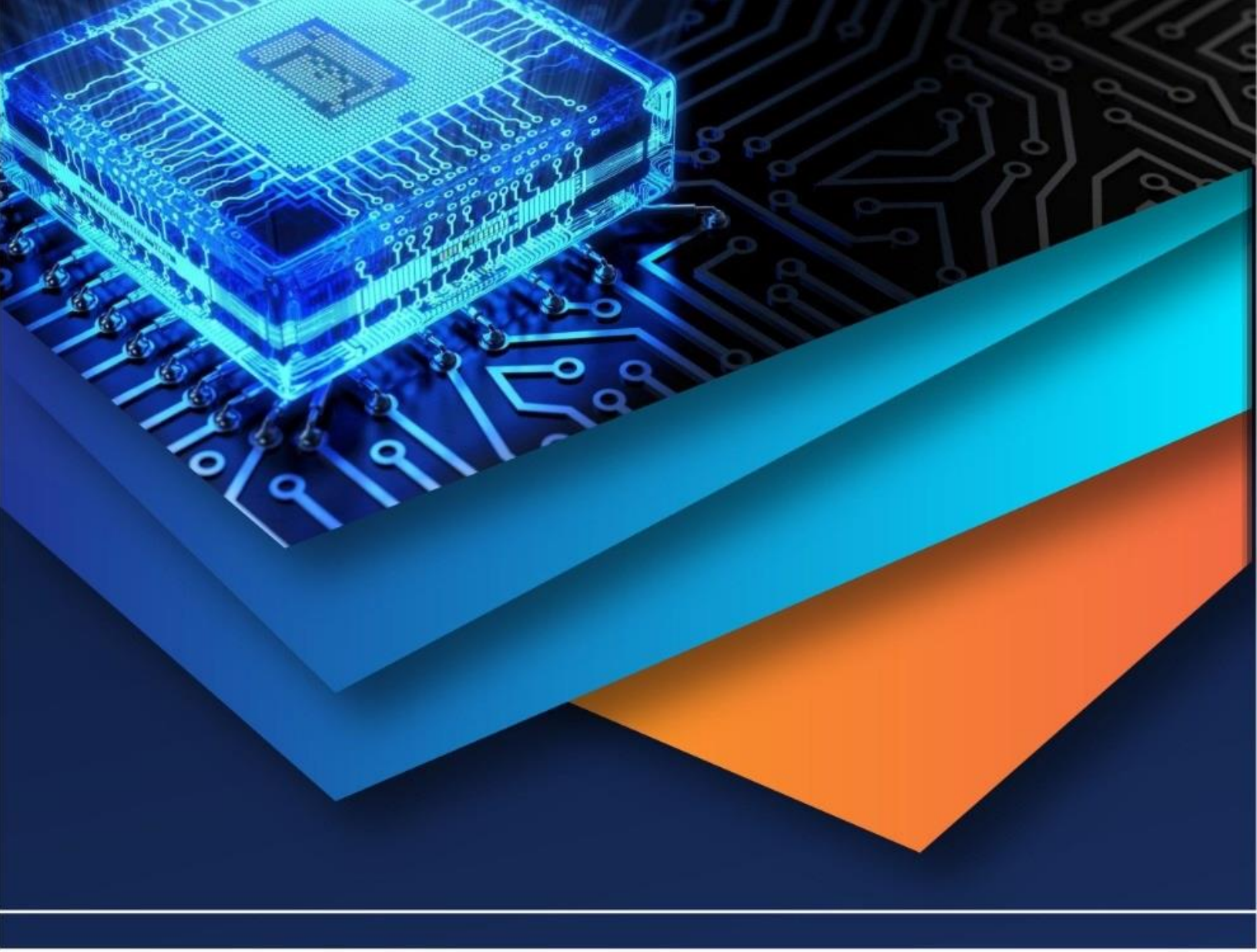
This project has been able to establish that, the need for a chainless bicycle that can function effectively and efficiently with minimal maintenance, yet is inexpensive to construct, is both possible and achievable. The overall cost and choice of materials would promote mass production

Thus the chainless bicycle is designed and fabricated where it can be implemented in day to day usage and the research on future bicycle is leading to effortless riding is ready to use.

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