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Design, Analysis and Fabrication of Hubless Bicycle

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Abstract: ***The cycle is the common mode of transport. Bicycle can be driven by all kind of individuals like children and senior citizen. But the old school sort of wheel which is being utilized for centuries has been given an unused plan which progresses the aesthetics of the cycle. In old bicycle the effort required to ride the bicycle is more. In the hubless cycle the gear transmission is provided which reduces the rider's effort to pedal and ride the bicycle. In normal cycle, the directing (i.e) the handle bar is joined to the centre of wheel. But in hubless wheel, the handle bar is attached to the wheel edge which increments steering efficiency. The cycle with ordinary look (i.e.) cycle with spoked wheel (centre wheels) is continuously being used everywhere and a substitute for the look isn't considered in plan. As it were the outlines and chassis of the cycle has been altered all through the ages. The wheel has remained the same. So, considering it as the most objective of our venture, the hubless cycle is designed.***
Keywords: Hubless Bicycle, Gear Train Drive.

I. INTRODUCTION

In popular we recognize that the cycle run on chain power mechanism and it is ideal and famous manner of transportation in rural as well as city area also. Due to the fact preliminary price may be very low, no gasoline is needed to run the bicycle. There is no threat to pollute the environment because of no use of fuel. But the bicycle used for many years now change only in looks of the frame of bicycle. In the traditional bicycle the rider needs to put more effort to ride because of the spokes attached to the rim of the cycle. When the rider pedals the sprocket rotates because of the chain and the spokes attached to the rim were forcefully rotated which causes the rider to put more effort to ride the bicycle.

So, considering it as the most objective of our venture, the hubless cycle is designed. In the hubless bicycle the rear rim have a internal gear mounted on it and the hub will be having the spur gear mounted on it. Because of the use of gears for transmission the rider will be needing less effort to ride the bicycle and as the spokes are removed it also give a new and stunning look to the bicycle.

II. LITERATURE REVIEW

Algat V.V., Bhalerao R.S., Autade K.N., Shimpi G.B., Prof. Ghodake A.P., explained in journal "HUBLESS WHEEL BICYCLE WITH GEAR TRAIN DRIVE MECHANISM" states that "The construction of Hubless wheel bicycle with gear train drive mechanism is designed to convert the human muscle power through pedalling work in to the mechanical work The system is assembled with the combination of pedals, shafts, one small size alloy wheel and one large size Hubless wheel which is function as driving wheel. The pedal and shaft are receiving the human effort and convert in to rotational mechanical motion. This rotational motion is transmitted up to the driving wheel via the spur gear drive train. The gear drive train is the combination of four stages of gear pair. These gear pairs not only transmit the power but also improve the gear ratio step by step. The gears and pinions of drive train are fixing with the bicycle body by using deep groove ball bearings. The last spur gear in the gear train is coupled with the driving wheel through the Hubless mechanism which also performs the holding function of driving wheel. The front wheel is small in size as compared to drive wheel and it only perform the system balancing function without actually participate in driving and driven mechanism. This system has ability to reduce the fatigue on bicycle rider by improving the power transmission efficiency and by extending the maximum limit of bicycle speed."

Bannetross said that the inventive device includes a frame having a seat structure and handle bar, rear bracket having rear bearings within that rotatably engages a rear wheel, a front bracket having front bearings within that rotatably engages a front wheel, and a drive train that engages the rear wheel for driving the rear wheel. The rear rim of the rear wheel includes a rear groove that receives the plurality of rear bearings. The rear rim of the rear wheel includes a rear gear that is engaged by a drive sprocket from the drive train.

Andrew J. Horst, in the paper "HUBLESS WHEEL AND RELATED STROLLER" states that "A seat is disposed on the frame. The Hubless Wheels are disposed on the frame. The Hubless Wheel includes a rim, an internal sliding structure and at least one bridging component. A tire is disposed on the Hubless Wheel. The rim has an external sliding structure on an inner surface of the rim. The internal sliding structure is disposed inside the external sliding structure. The bridging component is disposed between the external sliding structure and the internal sliding structure. The bridging component revolves on its own axis.

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Paul E. Lew, in the paper "Hubless Wheel" states that "A Hubless wheel for a vehicle which provides advantageous weight and aerodynamic properties. The wheel includes a rotationally stationary inner hoop, coupled to the vehicle, and a rotatable outer hoop, concentric with the inner hoop.

The inner hoop and outer hoop are both fabricated with a woven fiber composite shell. A ground engaging tread is disposed on the radial periphery of the outer hoop. Bearings, preferably three rotating bearings spaced circumferentially around the inner hoop at approximately 120° intervals, are mounted on the inner hoop to be rotationally stationary there with and each include a support surface on their respective radial peripheries.

The support surface is particularly contoured to operatively engage a bearing engaging surface located on the inner periphery of the outer hoop. The outer hoop is axially and radially supported relative to the inner hoop through this engagement to allow rotation there between."

Franco sbarro, said that a rotor is rotatable disposed and lateral bearings to laterally stabilize the rotor within the shround. A series of resiliently mounted bearings are spaced about the shround for rotatable retaining the rotor within the shround and for transmitting load and for absorbing any impact forces imparted to the rotors as it rolls over the ground.

Mohan Radhesh Mallaya et al, discussed that in this design, hubless wheel comprises of gear drive to transmit power from the motor to the wheel. this work focuses on using nylon MC 901 gears which is much lighter than their metal counter parts. The sun gear meshes with the internal gear ring made up of nylon MC 901 material. The power from the inner gear ring is transmitted to the rim by the bearings. The bearing are held on a bolt whose ends are connected to the stationary plates.

III. FABRICATION OF HUBLESS WHEEL

A. Rear Wheel

The internal gear is mounted internally on the rim of cycle through welding. The spur gear is mounted on the hub through welding and the sprocket is also mounted on the hub for transmission when the pedalling starts the chain rotates the fly wheel mounted on the hub and the spur gear also rotates as it is also mounted on the hub. When spur gear rotates it meshes with the internal gear mounted on the rim and forces the rim to rotate and then the bicycle will be in motion.



Fig.1: Internal Gear mounted on inner diameter of rim.

Spur gear is mounted on the hub by welding and the sprocket is mounted on one side of the hub where thread is present on the hub the sprocket is rotated when the rides stsrts pedallingthe sprocket rotates and chain rotates the sprocket. Sprocket and spur gear are mounted on the same hub so the spur also rotates.

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Fig.2: Spur Gear mounted on the hub.

Spur gear will be in continuous mesh with the internal gear mounted on the rim through welding when the hub rotates the spur gear rotates and it will rotate the internal gear so ultimately the wheel of the bicycle will rotate.

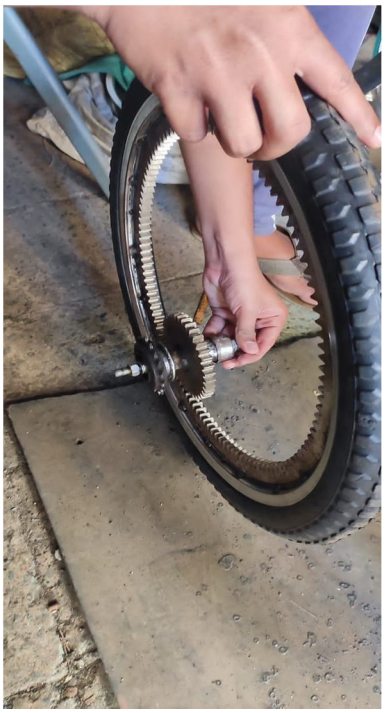


Fig.3: Position of spur gear in mesh with internal gear.

Smaller three spur gear are mounter on the roller bearing which will be in continuous mesh with the internal gear. These 3-spur gear will act as a supporting gear so that while riding the wheel will not be able to roll out and cause harm to the rider.

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Fig.4: supporting spur gear.

Side bearing is welded on the Mild Steel ring it will act as a barrier so that the M.S ring does not collide with the tyre and the internal ring gear. A total of 4 bearings are used on each side of the tyre so that the ring does not collide with the tyre.



Fig.5: Side bearing.

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B. Front Wheel

In front wheel the roller bearing is mounted on the Mild Steel ring through nut and bolt and the bearing will be in continuous contact with the inner surface of the rim. These bearing will act as a supporting so that the front wheel will not roll out while riding and cause any incident. 3 small diameter bearing are also used as a barrier so that the M.S ring does not collide with the front wheel tyre. The small bearing will be in continuous contact with the side surface of the rim.



Fig.6: Support bearing mounted on M.S ring through nut and bolt and side bearing mounted on ring though nut and bolt.



Fig.7: Front wheel mounted on the bicycle frame.

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C. Design of Hubless Cycle

The rear and front wheel are mounted on the frame of the cycle through welding the Mild Steel semi circular arc is welded to the front and back side of the famre fork. Then the M.S arc is drilled and is mounted on the ring of the through nut and bolt.



Fig.8: Assembly of Hubless Bicycle.

IV. METHODOLOGY

Improved aesthetics of the cycle was kept as the vision of the project. First of all, the selection of cycle was done and the Roto bike 360 freestyle cycle was selected. Then according to the inner diameter of rim the internal gear was made having 116 teeth and then spur gear was made with 36 teeth and 3 small spur gear having 14 teeth each. Then in next step Mild Steel ring was made which is used to mount the gears on it and also the weight of the bicycle and also the rider's weight will be handle by the Mild Steel ring.

Then a rectangular steel plate was welded on the M.S ring facing towards the rim. Drilled was done on the rectangular steel plate and then small bearing was fitted on the plate through nut and bolt on all the four rings total of four plates were welded on each ring so on each side of the wheel 4 bearings were mounted on rings so total 8 side bearings are mounted on the rear wheel. Then a rectangular steel plate of 3mm thickness and 50.8mm in height was welded on the surface of all the four rings total of 3 plates was welded on each ring. Drill was done on the rectangular plate welded on the surface of the ring and then a bolt of 127mm long was pass through out the plate to the ring which was on other side of the tyre. Small spur gear was mounted on the bolt and adjusted so that they are in mesh with the internal gear. Total of 3 small spur gear were mounted on ring of the rear wheel. These 3 spur gears having 14 teeth each act as supporting gear so that the tyre does not roll out while riding.

Front wheel structure is same as the rear wheel a rectangular steel plate was welded on the M.S ring facing towards the rim. Drilled was done on the rectangular steel plate and then small bearing was fitted on the plate through nut and bolt on all the four rings total of four plates were welded on each ring so on each side of the wheel 4 bearings were mounted on rings so in total 8 side bearings are mounted on front wheel. Then a rectangular steel plate of 3mm thickness and 38.1 mm in height was welded on the surface of all the four rings total of 3 plates was welded on each ring. Drill was done on the rectangular plate welded on the surface of the ring and then a bolt of 127mm long was pass through out the plate to the ring which was on other side of the tyre. Bearings are mounted on the bolt and adjusted so that they are in contact of the inner surface of the rim.

Then a semi-circular arc was cut through laser cutting. Total of 8 semi-circular arcs was cut 4 for the front wheel and 4 for the rear wheel. 2 arcs were welded on the surface of the M.S ring and 2 arc were welded to the cycle fork then all the 4 arc was drilled 2 whole on each arc then a bolt of 152.4mm was pass through out the drilled hole to the other side of the arc which is welded on the fork of the cycle. Then through nuts it is fitted to the cycle.

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Then 2 Rectangular plates of 5mm thickness were on welded on the ring of rear wheel each plate is drilled. Spur gear having 36 teeth is welded on the hub. The hub is mounted on the rectangular plate of 5mm thickness which is mounted on the ring of the rear wheel and on hub a sprocket having 18 teeth is mounted. When Rider starts pedalling then it forces the sprocket to rotate. The sprocket is mounted on the hub and the spur gear having 36 teeth is also mounted on the hub so when rider starts pedalling the spur gear also rotates. The spur gear is in continuous mesh with the internal gear mounted on the rim of the cycle. So, when spur gear rotates it rotates the internal gear mounted on the rim and when rim starts rotating the cycle is in motion.



Fig.8: Hubless Bicycle.

V. CALCULATION

A. Internal Gear

M (Module) = 3
P (Pitch) = π x M = π x 3 = 9.494mm.
T (Number of Teeth) = 116.
ID (Internal Diameter) = 342mm.
OD (Outer Diameter) = 354mm

B. Spur Gear

M (Module) = 3
P (Pitch) = π x M = π x 3 = 9.494mm.
T (Number of Teeth) = 36.
ID (Internal Diameter) = 25mm.
OD (Outer Diameter) = 114mm.

C. Pedal Sprocket

M (Module) = 1.5
P (Pitch) = π x M = π x 3 = 4.71mm.
T (Number of Teeth) = 54.
ID (Internal Diameter) = 25mm.

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D. Hub Sprocket

M (Module) = 1.5
P (Pitch) = π x M = π x 3 = 4.71mm.
T (Number of Teeth) = 18.
ID (Internal Diameter) = 36mm.

E. Gear Ratio

Internal gear no of Teeth: 116
spur gear no of Teeth: 36
pedal sprocket no of Teeth: 54
Hub sprocket no of Teeth: 18
Pedal sprocket to Hub sprocket gear ratio: 54/18 = 3.
As Spur gear is mounted on the same hub so Spur gear also rotates 3 times on one rotation of Pedal sprocket.
Spur gear have 36 teeth and Internal gear is having 116 teeth.
As spur gear rotates 3 times so 36 teeth x 3 = 108 Teeth.
Internal gear is having 116 teeth so when spur gear rotates 3 times then spur gear travels 108 teeth from 116 teeth.
So, the Gear ratio is 108 / 116 = 0.93.
So, When Pedal sprocket completes One rotation then the rear wheel completes One rotation as well i.e. The ratio of the cycle is 1:1.

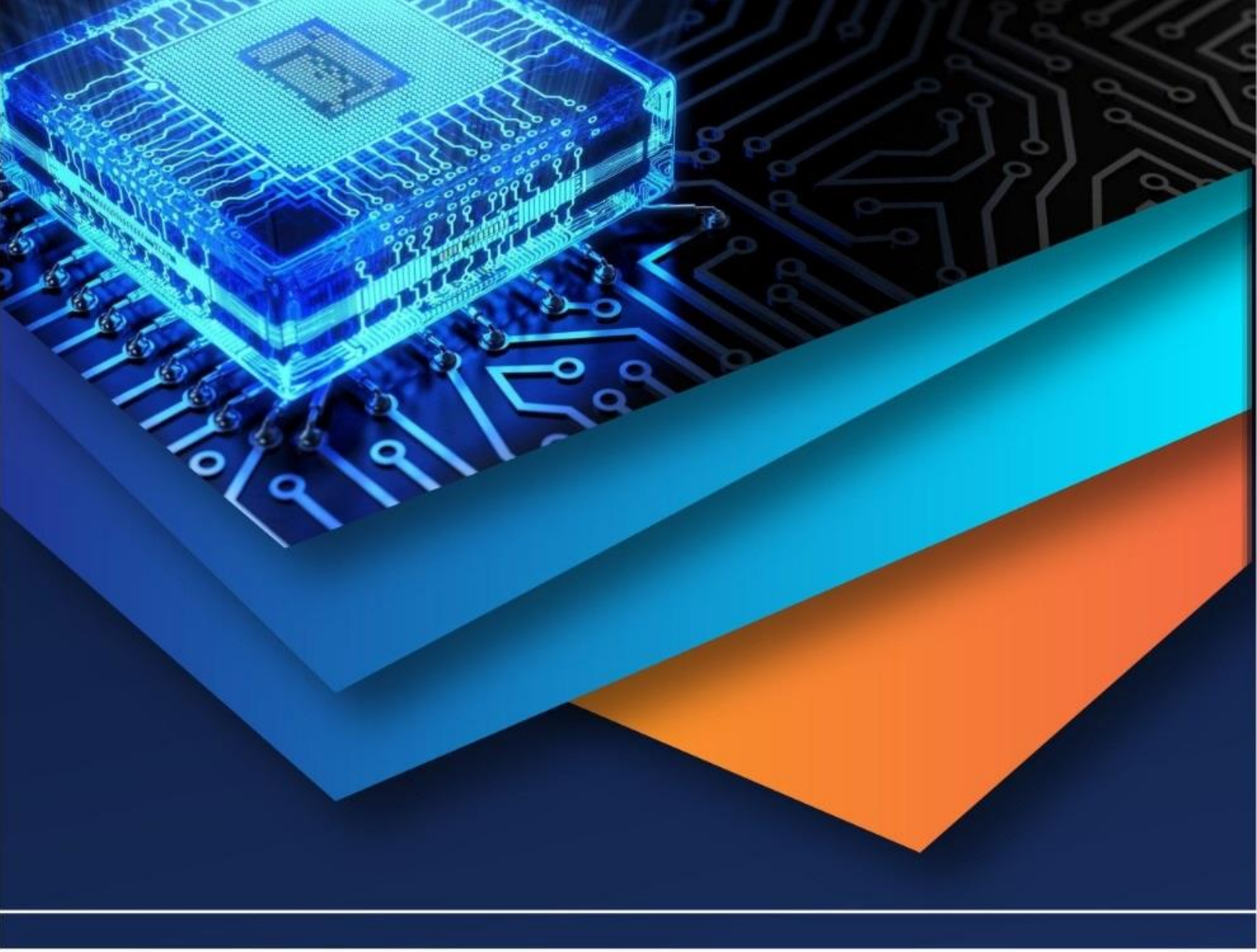
VI. CONCLUSION

Thus, the project enhances the aesthetics of the conventional cycle by giving it a good look. The use of gears also reduced the effort of the rider to pedal. The steering efficiency is also increases because the cycle fork is mounted on the ring directly. The load carrying capacity also increases because of the strength of Mild Steel ring which is welded to the bicycle frame. The weight of the cycle can be reduced by using nylon gears or composite nylon gears.

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