Design and Fabrication of Shaft Drive for Bicycle

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Abstract— A shaft-driven bike is a bike that uses a determined shaft rather than a chain to transmit power from the pedals to the wheel. Shaft drives were presented over a century prior, yet were generally supplanted by chain-driven bikes because of the apparatus ranges conceivable with sprockets and derailleur. Recently, because of progressions in inward apparatus innovation, a little number of current shaft-driven bikes have been presented. The shaft drive just needs intermittent oil utilizing an oil weapon to keep the rigging running calm and smooth. This "chain less" drive framework gives smooth, very and productive exchange of vitality from the pedals to the back wheel. It is appealing in look contrast and chain driven bike. It replaces the convectional.
Key words: Shaft, Straight Bevel gear, Bicycle

I. Introduction

A shaft-driven bike is a bike that uses a drive shaft rather than a chain to transmit power from the pedals to the wheel course of action. Shaft drives were presented over a century back, yet were basically supplanted by chain-driven bikes because of the rigging extents conceivable with sprockets and derailleur. As of late, because of progressions in inward apparatus innovation, a little number of cutting edge shaft-driven bikes have been presented. Shaft-driven bicycles have a huge angle gear where an ordinary bicycle would have its chain ring. This cross sections with another angle apparatus mounted on the drive shaft. Replacement of chain drive bike with drive shaft. The utilization of slant apparatuses permits the drive's hub torque from the pedals to be turned through 90 degrees. The drive shaft then has another angle apparatus close to the back wheel center point which work with an incline gear on the center where the back sprocket would be on a traditional bicycle, and counteracting the first drive torque change of axis.

A. Use Of Drive Shaft

The torque that is delivered from the pedal and transmission must be exchanged to the back wheels to push the vehicle forward and turn around. The drive shaft must give a smooth, continuous stream of energy to the axles. The drive shaft and differential are utilized to exchange this torque.

B. Functions Of The Drive Shaft

1) To begin with, it must transmit torque from the transmission to the foot pedal.
2) Amid the operation, it is important to transmit most extreme low-outfit torque created by the pedal.
3) The drive shafts should likewise be fit for turning at the quick speeds required by the vehicle.

II. Components

In the shaft drive bicycle several component use are as follow

A. Paddle

A bike pedal is the piece of a bike that the rider pushes with their foot to move the bike. It gives the association between the cyclist's foot or shoe and the wrench permitting the leg to turn the base section axle and move the bike's wheels. Pedals more often than not comprise of a shaft that strings into the wrench's end and a body, on which the hassocks or is appended, that is allowed to pivot on orientation concerning the axle. Part joined to wrench that cyclist turn to give the bike power; it comprises of three fragments.

B. Fender

Piece of blended metal covering a piece of wheel to shield the cyclist from being sprinkled.

C. Front Brake

Instrument initiated by brake link packing a caliper of return springs. It drives a couple
of brake cushions against the sidewalls to stop the bike.

D. Hub

Focus a wheel's portion from which talked transmit, inside the center are metal balls empowering to turn around in hub.

E. Bevel gear

A sort of apparatus in which the two wheels cooperating lie in distinctive planes and have their teeth sliced at right edges to the surfaces of two cones whose apices agree with the point where the wheels' tomahawks would meet.

F. Driven Shaft

A pole driven bike is a bike that uses a drive shaft rather than a chain to transmit power from the pedals to the wheel. Shaft drives were presented over a century prior, yet were basically supplanted by chain-driven bikes because of the rigging extents conceivable with sprockets and derailleurs. As of late, because of headways in inward rigging innovation, a little number of present day shaft-driven bikes have been presented.

G. Bearing

For the smooth operation of Shaft, bearing system is utilized. To have less rubbing misfortune the two finishes of shaft are rotated into the same measurement bearing.

III. CALCULATIONS

A. Design Calculation for Gear

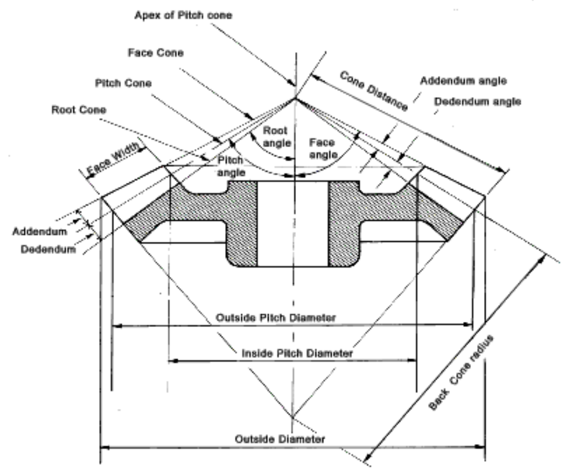

Fig. 1: Design of Bevel Gear

1) Assumption

Speed of gear (Ng) = 100rpm
Velocity ratio =3
Teeth of pinion (tp) = 18
Mass of rider (m) = 60 kg
Length of the pedal lever (L) = 190 mm Step:1) Maximum torque applied on bicycle
= (Mass of rider x g) x Length of the pedal lever
= 60 x 9.81 x 0.19
= 111.83 N-m
Step:2) Calculate Rated power
P_R = 2πNT / 60
= (2π x 100 x 111.83) / 60
= 1.172 KW
Step:3) Select suitable teeth of pinion
tp = 18
V.R. = tg / tp
V.R. = Np / Ng
3 = tg / 18
3 = Np / 100
tg = 54
Np = 300 rpm
Step:4) Pitch angle
For pinion, tan γp = tp / tg
For gear, tan γg = tg / tp
γp = tan-1 (18/54)
γg = tan-1(54/ 18)
γp = 18.43°
γg = 71.57°
Step:5) Module
m = D / t
D = m x t
Dp = m x tp
Dg = m x tg
Dp = m x 18
Dg = m x 54
Cone distance
L^2= 0.5 x(Dg^2+Dp^2)
L = 28.46 x module
Step:6) Formative number of teeth
(tf)p = tp / cosγ_p (tf)g = tg / cosγ_g
(tf)p = 18 / cos (18.43°) (tf)g = 54 / cos(71.57°)
(tf)p = 18.97 ≈ 19 (tf)g =170.80 ≈ 171
*Step:7) Design power
Pd = PR x KL
Where, Load factor KL = 1.25
Pd = 1.172 x 1.25
Pd = 1.465 kW
*Step:8) Tangential or tooth load
F_t = Pd / Vp
Where, Vp = (π x Dp x NP / 60000)
= (π x 18m x 300 / 60000)
= 0.2826 m m/s
Therefore;
Ft = (1.465 x 1000) / (0.2826 x m)
Ft = 5184/m
*Step:9) Beam strength
Y = Lewis Factor
For pinion,
Yp = 0.154- (0.912 / $(t_f)_p$)
Yp = 0.154- (0.912 / 18)
Yp = 0.1059
For gear, Yg = 0.154- (0.912 / $(t_f)_g$)
Yg = 0.154- (0.912 / 72)
Yg = 0.1486
B = Face width of gear
B = L/3=9.45 m
Now,
For pinion (σ x Y)P = (100 x 0.3255) = 10.59
For gear (σ x Y)g = (100 x 0.4451) = 14.86
FB = σ x π x Y x b x m (1– b/L)
=209.89*m*m N
Feff =C_s*f_t/C_v Cv = 3/(3+v)
=1.25*5184/0.9665 =0.9665
=6703.9/m
Feff *FOS=1.5*6703.9/m
=10055.96/m
In order to avoid failure,
Feff*FOS=Fb
10055.96/m=209.89*m*m
m=3.63≈4
Dimension of gear
b = 32 mm
Dp = m*Zp=72 mm
Dg = m*Zg=216 mm
L= 28.46*m =113.84 mm
Ha= m = 4 mm
Hf= 1 mm
Thickness (T)= 1.5708*m = 6.28 mm

B. Design Calculation For Shaft

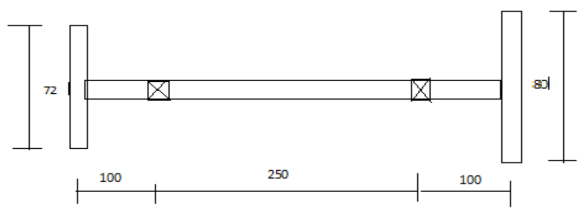

Fig. 2:

1) Data Available

Power (P) = 1.465 kW = 1.465 x 103 W
Speed (N) = 300 rpm
Mass (m) = 60 kg
Weight of 1st pinion (WA) = 5 N

Weight of 2nd pinion (WB) = 5 N
Shear stress (τ) =130 mPa Fatigue factor, Km = 1, Kt =0.5
Torque applied,

$$T = (P \times 60) / (2\pi \times N)$$
$$= (1.465 \times 103 \times 60) / (2\pi \times 200)$$
$$T = 46.63 \text{ N-m}$$
$$= 46630 \text{ N-mm}$$

Total vertical load acting downward on the shaft at A,

$$Ft_{(A)} = (T / R_A)$$
$$= (46650) / (36)$$
$$= 1295.83\text{N}$$

vertically upward on the same gear B,

$$Ft_{(B)} = (T / R_B)$$
$$= (46630) / (40)$$
$$Ft_{(B)}= 1295.25 \text{ N}$$

total downward force acting at A;

$$F_{ta}+F_{tb}+W1= 1295.83+1295.25+5$$
$$=2595.68 \text{ N.mm}$$

Moment @ A;

$$= 2595.68*60$$
$$=155741 \text{ N.mm}$$

total downward force acting at B;

$$F_{ta}+F_{tb}+W2 = 1295.83+1295.25+5$$
$$= 2595.68 \text{ N.mm}$$

Moment @ B;

$$= 2595.68*60$$
$$= 155741 \text{ N.mm}$$

shaft diameter on strength basis;

$$\tau^2_{(max)} = (16/\pi d^3)((K_b M_b)^2+(K_t M_t)^2)$$
$$D = 20 \text{ mm}$$

C. *Assembly*

Fig. 4:

D. *Advantages*

- Drive system is less likely to become jammed.
- The use of a gear system creates a smoother and more consistent pedaling motion.
- Lower maintenance.
- Efficiency is more as compared to conventional bicycle design.
- High durability.
- Low cost of ownership when manufactured in large scale.

IV. SHAFT DRIVE V/S CHAIN

Features	Shaft Drive Bicycles	Sprocket-Derailleur Bicycles
Drive Mechanism	Bevel gear and Shaft Drive	Chain and Sprocket Drive
Maintenance	Periodic Grease added to Shaft Drive -fast and easy	Requires adjustment of derailleur's by trained bike mechanic; periodic chain cleaning and lubrication
Durability	High durability	Low durability as compare to shaft drive
Ground Clearance (to drive system parts)	13+ inches to shaft drive	~ 8 inches to derailleur, chain and sprocket
Efficiency	90%+ efficient (consistently with minimal maintenance)	75 - 95% efficient(varies depending on condition and upkeep)
Noise	Low - runs virtually silent	Can vary depending on condition of chain & alignment of derailleur

Fig. 5:

V. APPLICATIONS

- It is used for racing purpose.
- Also used for Off-road riding.
- For Cycling.
- For public and bicycle rental purpose.

VI. RESULT & CONCLUSION

- The presented work was aimed to reduce the wastage of human power on bicycle riding.
- The presented work also deals with optimization i.e. converting rotary motion into the linear motion with aid of two bevel gears.
- Instead of chain drive one piece drive shaft for rear wheel drive bicycle have been optimally designed and manufactured for easily power transmission.
- The result obtained from this work is a useful approximation to help in the earlier stage of the development, saving development time and helping in the decision making process to optimize a design.
- Hence we are trying to make the transmission smooth and easy by applying the bevel gears and shaft attachment instead of chain, chain sprocket.

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