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Improve the Geometric Profile of the Sprocket Wheel in Power Transmission System of Bicycle for Adjustment the Amplitude of Pedal Acceleration

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ABSTRACT

Based on the results achieved using experimental data and related mechanical analysis, the magnitude of loads that a bicyclist can apply on the pedal at his extreme power, is a function of angular coordinates of pedals. Therefore, the resultant of torques which these loads apply at the axle of pedals has an oscillation nature. To avoid transferring the oscillations produced by torques to the bicycle's propellant wheel which causes fluctuations in the bicycle acceleration, a special power transfer system should be used. Designing of such mechanisms is the objective of this project. Foresaid design is a optimized instance of ordinary systems of mechanical energy generation using the method of pedaling, in which, for transferring the power from the pedal axle to the chain an ellipsoid chair wheel is used.

Regarding to the properties of the new chain wheel, the way that it transfers the power, can decrease the frequent oscillations of torque at pedal axle. Thus, the procedure of accelerating of bicycle which uses this system of power transfer will be almost without oscillations.

KEYWORD

Frequent Torque, Oscillation Amplitude, Bicycle, Mechanical Analysis, Ellipsoid Chair Wheel.

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1- INTRODUCTION

Crank mechanism is the conventional method for converting the muscular energy to mechanical required to drive bicycles. A crank is an arm attached at right angles to a rotating shaft by which reciprocating motion is imparted to or received from the shaft. It is used to convert circular motion into reciprocating motion, or vice-versa. The arm may be a bent portion of the shaft, or a separate arm or disk attached to it. Attached to the end of the crank by a pivot is a rod, usually called a connecting rod. The end of the rod attached to the crank moves in a circular motion, while the other end is usually constrained to move in a linear sliding motion.

The term often refers to a human-powered crank which is used to manually turn an axle, as in a bicycle crankset or a brace and bit drill. In this case a person's arm or leg serves as the connecting rod, applying reciprocating force to the crank. There is usually a bar perpendicular to the other end of the arm, often with a freely rotatable handle or pedal attached.

In this mechanism, the pedal claw applies the mechanical torque to the crank shaft [1-5].

The purpose of this study is to design a power transmission system in which the amplitude of the fluctuations in the torque generated by the drive axles to be lowest. Reduction in the amplitude of the torque being monotonic linear acceleration of the bike will follow.

2- METHODOLOGY

In this paper, a theoretical model of power transmission mechanism in the conventional bicycle is introduced. The model is approved via experimental tests**.**

Considering the approved model, to optimize the torque fluctuation during each pedaling cycle, the profile of the pedal side`s sprocket wheel must be modified from circle curve to a semi elliptic one**.**

The final step is to verify the performance desired wheel, chain wheel and built a prototype was installed on the bike. In this way, several works have been done by researchers [6-17].

The purpose of this experiment is to investigate how changes in the angular momentum of the applicable cyclist pedals to change the torque profile is based on the estimation of approximate geometric structures suitable for offered sprocket.

3- RESULTS AND DISCUSSIONS

For this purpose, we used a simple mechanism in which one end of the chain which is placed under traction of pedal side`s sprocket wheel, is jointed with a force meter [6-17]. The force meter`s load is adjusted with the torque applied to wheel axis**.** Multiplying the measured force by its distance from wheel axis, the maximum torque which a particular cyclist can apply to the sprocket wheel`s axis, in each pedal`s handle angular position, is calculated (Table 1).

Table1: maximum torque applied in each pedal`s handle angular axis in conventional power transmission mechanism

θ	0	10	20	30	40	50	60	70	80	90
M	1.116	1.186	1.213	1.283	1.343	1.383	1.443	1.503	1.576	1.630
θ	90	100	110	120	130	140	150	160	170	180
M	1.630	1.576	1.503	1.443	1.383	1.343	1.283	1.213	1.186	1.116
θ	180	190	200	210	220	230	240	250	260	270
M	1.116	1.186	1.213	1.283	1.434	1.383	1.443	1.503	1.576	1.630
θ	270	280	290	300	310	320	330	340	350	360
M	1.630	1.576	1.503	1.443	1.383	1.343	1.283	1.213	1.186	1.116

The polar diagram, representing the applied maximum torque versus its pedal`s angular position is traced (Fig 1).

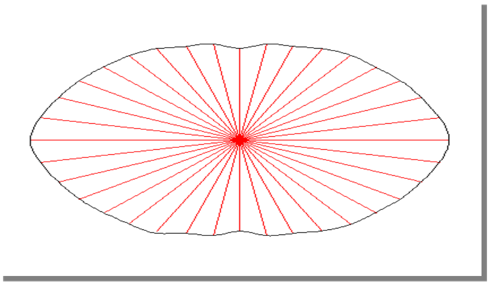

Fig1: the applied maximum torque versus its pedal`s angular position

The results determine that the maximum torque can be varied from 1.116Nm at 0 D. to 1.630Nm at 90 D. and that its variation trace is similar to an ellipse curve. The bicycle chain transmits this torque variation to the next sprocket wheel. Consequently, the result introduces a cyclic variation in bicycle acceleration. To avoid this undesirable effect, the applied torque has to be altered during each cycle time of pedaling.

Supposed that the muscular force which cyclist can apply to a pedal, in a given pedal`s handle angular position, is limited, the result torque can be modified if the wheel radius is varied.

Therefore, to alter the variation of torque, we proposed a new pedal side`s sprocket wheel in which the wheel dents are arranged around an elliptic curve (Fig2)**.** To install this optimal design sprocket wheel, it will be attention that its little diameter is aligned with the pedal`s handle (Fig3)**.**

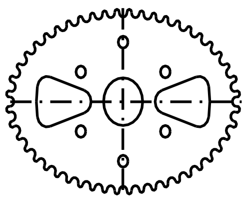

Fig2: the proposed design for pedal side`s sprocket wheel

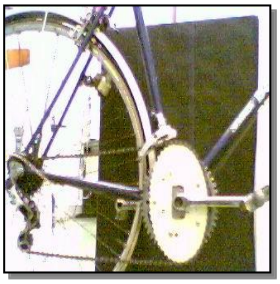

Fig3: a prototype bicycle which is made based on the optimal design sprocket wheel

To measure the maximum torque which a particular cyclist can apply on the optimal sprocket wheel axis in each pedal`s handle angular position, the above specified tests is repeated (Table 2). Comparing data in table 2 with respect to table 1, results that the proposed sprocket wheel can goodly altered the fluctuation of torque.

Table 2: maximum torque applied in each pedal`s handle angular axis in above specified tests of power transmission mechanism

θ	۰	۱۰	۲۰	۳۰	۴۰	۵۰	۶۰	۷۰	۸۰	۹۰
M	1/33	1/34	1/34	1/33	1/32	1/33	/135	1/33	1/35	1/33
θ	۹۰	۱۰۰	۱۱۰	۱۲۰	۱۳۰	۱۴۰	۱۵۰	۱۶۰	۱۷۰	۱۸۰
M	1/33	1/35	1/33	1/35	1/33	1/32	1/33	1/34	1/34	1/33
θ	۱۸۰	۱۹۰	۲۰۰	۲۱۰	۲۲۰	۲۳۰	۲۴۰	۲۵۰	۲۶۰	۲۷۰
M	1/33	1/34	1/34	1/33	1/32	1/33	/135	1/33	1/35	1/33
θ	۲۷۰	۲۸۰	۲۹۰	۳۰۰	۳۱۰	۳۲۰	۳۳۰	۳۴۰	۳۵۰	۳۶۰
M	1/33	1/35	1/33	1/35	1/33	1/32	1/33	1/34	1/34	1/33

4- CONCLUSION

In this mechanism, the mechanical energy produced by the two methods was evaluated on a bicycle. After addressing the weaknesses of the existing mechanisms for the transfer of an optimal system of muscular energy to mechanical torque needed to move the bike was proposed.

According to the forecast charts, graphs resultant torque than the angle of rotation of the pedal in a polar coordinate system will be an ellipse-like curve.

Experimental results show that the mechanism will meet our demands and suitable mechanisms for the same torque is obtained.

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