

## The Power-train for the Bicycle adopting the Timing belt

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### Abstract

Currently, the most important issue on the earth is global warming, which causes climate change and leads to disasters. For this reason, each country is focusing on renewable energy, carbon neutrality, environmentally friendly energy and transportation. Bicycles used as short-distance vehicles do not emit gases harmful to the human body that pollute the Earth's atmosphere. Also, the use of bicycles has the effect of improving the health of people, and each country is designing a short distance transportation network using bicycles. In this study, we propose a model of a bicycle power-train that can use a belt as a power transmission medium. The basic principles and methods for applying the proposed new type of power-train to bicycles are presented.

**Keywords:** Power-train, Power-train Medium, Bicycle, Timing Belt, Pulley.

## 1. Introduction

Bicycles and electric bicycles, which can prevent global warming and air pollution and have exercise effects, are attracting attention as a means of short-distance transportation in cities, and for this reason, countries are expanding to shared bicycles and shared electric bicycles. Chain and sprocket are the most widely used power-train devices for existing bicycles, and the price of bicycles is increasing due to the improvement of materials and the upgrading of manufacturing of these components. On the other hand, China and other countries are increasing their market share with mass production means[1, 2, 3].

In this study, we propose a new type of power-train that can replace the conventional power-train of bicycles using chains and sprockets, and the proposed power-train uses a belt as a power-train medium. It is same Fig. 1 that pulley of the power-train applying the belt[1, 2]. In the central axis of pulley, the spline of the linear type is installed and the rotational motion possible. The structure performing shift the inclined spline is established

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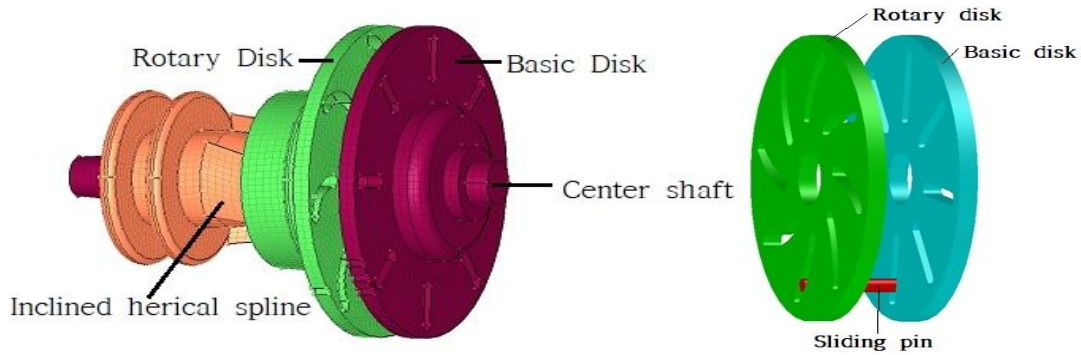
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on the spline of the linear type, and the inclined spline is shaved the shaft of pulley or it draws and the rotational plate is rotated. The basic disk installed at the end of pulley and rotary disk are connected to the sliding pin. The structure of the pulley is shown in Fig. 1.

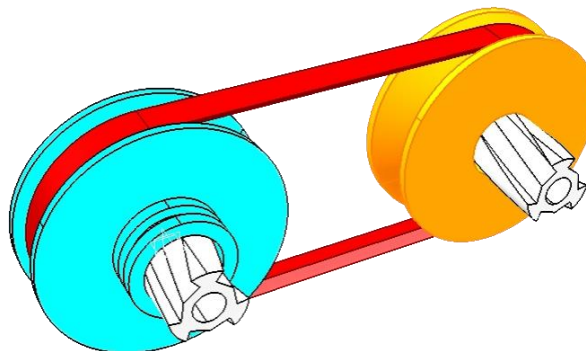


**Figure 1. The pulley of power-train for bicycle**

In order to perform the shifting, the inclined spline is moved in the axial direction of the pulley to rotate the rotary disk, and the position of the sliding pin is changed to perform the shifting. In addition, it is possible to apply the cross-sectional shape of the sliding pin to the timing belt, which is a power-train medium, and to have a shape corresponding to the pitch of the timing belt.

## 2. The structure of power-train

If it applies to the power-train of bicycle by using the pulley structure of Fig. 1, it is as shown in Fig. 2. In order to apply the pulley of the proposed power-train device to a bicycle, it is possible to apply it by dividing it into a driving unit having a pedal and a driven unit of a rear wheel. However, the timing belt is used as the applied power-train medium[4, 5, 6]. Since the length of the applied belt is limited, when the belt pitch radius of the driving unit increases, the belt pitch radius should be reduced in the driven unit by the same amount[7, 8, 9]. To this end, inclined spline for performing a shifting process in the driving unit and the driven unit must be installed in the reverse direction[10, 11].



**Figure 2. Concept of power-train for bicycle**

In order to apply the power-train device of Fig. 2 to bicycles and electric bicycles and to apply the timing belt as a power-train medium, the cross-sectional shape of the sliding pin connecting the basic disk and the

rotary disk must be in contact with the timing belt. The picture reflecting this is shown in Fig. 3. The cross-sectional shape should be designed considering the pitch spacing of the timing belt.

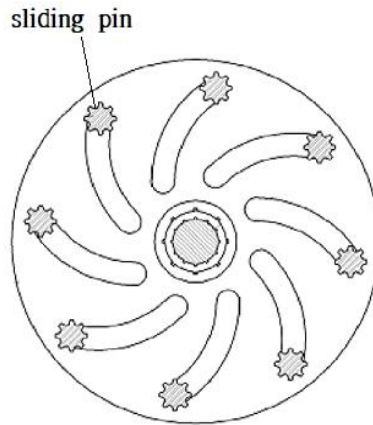


Figure 3. Sliding pin of shaped timing belt

### 3. Shifting process

The proposed power-train device can rotate through a linear spline installed at the center of the pulley. The power-train device should be able to shift while rotating according to the driver's request. The process of performing shift is shown in Fig. 4.

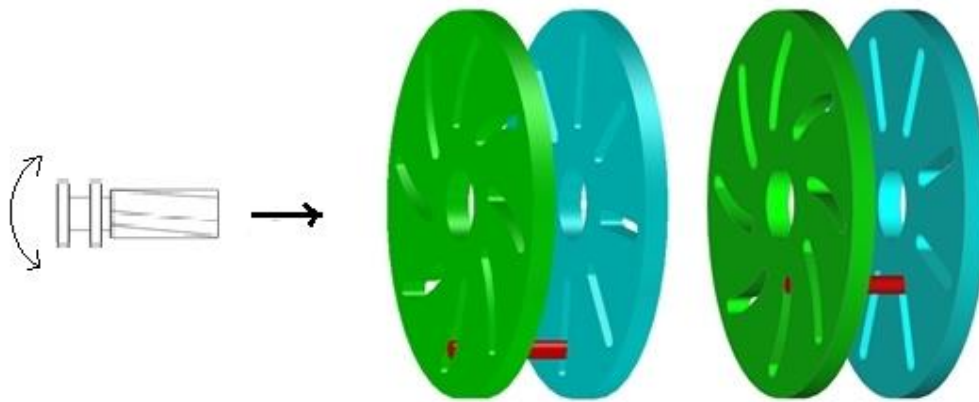
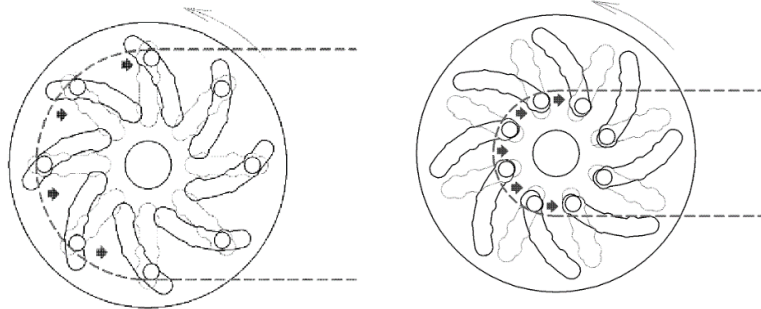


Figure 4. Shifting process

The spline of the sloped shape is moved the shaft and the rotary plate is rotated. Accordingly, the position of the sliding pin connected to the basic disk changes. The pitch radius of the belt covering the sliding pin changes and the shift is made.

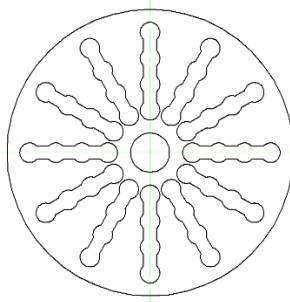
Conventional bicycles are used to change the speed of the bicycle depending on the driver's will during driving, which may be to increase the speed of the bicycle or to increase the torque during hill driving to reduce the driver's stress. In the proposed power-train model, a slot is formed in the basic disk and the rotary disk, a

seating groove is formed in the slot to form a shift stage, and Fig. 5 shows a shifting process by placing a seating groove formed in an arc-shaped slot.



**Figure 5. A change speed of basic disk and rotary disk equipped seating groove**

In addition, when the slot is in a linear shape, a shift gear can be formed by placing a seating groove as shown in Fig. 6, and stable driving of a bicycle can be achieved by placing a seating groove and forming a shift gear.



**Figure 6. The linear type slot having seating groove**

The form of attaching the power transmission device for the bicycle proposed in this study is shown in Fig. 7.



**Figure 7. Proposed power-train attached to bicycles**

## 4. Conclusion

As a means of transportation to prevent global warming and air pollution, the use of efficient bicycles and electric bicycles is increasing. In this paper, a new type of power-train applicable to bicycles and electric bicycles is proposed, which uses a timing belt as a power-train medium. The following conclusions were obtained by studying the model of a new type of bicycle power-train.

1) By using the spline setting up the spline of the linear type in the center of axis of pulley, and is inclined in the upper part, shift is performed.

2) The inclined spline installed at pulley is transferred shaft and shift can be done.

3) The seating groove is left in the basic disk or the rotary disk and the shift gear number can be given, the stable driving possible.

4) If the cross section of the sliding pin interlinking the basic disk and rotary disk is tallied with the pitch of the timing belt, the application of the timing belt possible with the power-train medium.

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