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Continuously Variable Transmission Using Quadric Crank Chains and Ratchets

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Abstract. This paper describes the continuously variable transmission (CVT). Generally, CVTs are classified as belt-type or toroidal CVTs, and each CVT is basically composed of two parts such as the V-belt and pulley, or friction wheels. In the belt-type CVT, the pulley is driven by a belt placed between two (left and right) circle boards in the pulley, while in the toroidal CVT, two rollers rotate under the condition being pushed by strong compression power. Since these conventional CVTs use friction force, their energy transfer efficiency might be inferior. Furthermore, although these CVTs require precise structures and processing, they make noise, and are not durable. Consequently, we propose a new structural CVT in this paper.

Key words

Continuously Variable Transmission, Quadric Crank Chain, Link Mechanism, Cam, Ratchet

1. Introduction

The power transmission mechanism between the input side and the output side in vehicles or turbines includes the gear transmission mechanism, the traction mechanism, friction belts, pulleys, the drive shafts, and the torque converter, etc. The transmission mechanism between the engine side (input side) and the wheel shaft side (output side) is used to change not only the power (force, torque) but also the rotation speed (Fig. 1).

There are two main types of variable transmissions: the multistage type of gear transmission and the continuously variable transmission (CVT) [1]. Since the CVT can continuously change the gear ratio, in theory it should have high transmission efficiency. However, in the conventional CVT, there is significant power loss because the CVT mechanism is a conduction mechanism with friction power occurring under high pressure at the contact points between transmission mechanisms. That is, the internal forces generated by the friction power at the contact points do not cause any work loads, but they cause the dissipation energy.

We here propose a new type of CVT to compensate for the loss that originates in this high pressure [2]-[4]. In this mechanism, which makes use of closed loop-like links of a quadric crank chain, there is a symmetrical arrangement of two crank-rocker mechanisms, which are composed primarily of a closed loop consisting of four links. The type of the movement in each crank-rocker mechanism depends on the relationship between the lengths of the links. In the transmission, the rotation mechanism of the crank serves as the input function, and the rocker mechanism serves as the function of the output side. Then, the power which is generated by the back-and-forth angular movement of the rocker is transferred to the outside rotation mechanism of a output internal gear which connects to the wheel mechanism such as a tire. In the crank-rocker mechanism, the speed ratio can be changed without stage by changing the length of the crank continuously. The ratchet mechanism is used to transmit power from the movement of the rocker to the above-mentioned output rotation mechanism by means of a pawl installed in each rocker, which intermeshes alternately to the ratchet mechanism. (The ratchet may be changed to the one-way clutch in the future). Since this proposed mechanism is not friction-generated under high pressure conditions, it is thought that the transmission efficiency will be greater.

2. Conventional CVT mechanisms

The conventional belt-type CVT is a mechanism that transmits power with a V-belt and two pulleys, as shown in Fig. 2. The part where the right and left pulleys are in contact with the belt has the shape of a taper. The position at which the belt hangs relative to the pulleys changes continuously along the direction of the rotation axis, and the distance between the two pulleys shortens or lengthens. That is, the gear ratio can be changed smoothly by controlling the effective diameter of the pulley to contact with the V-belt to transmit the force and torque. Until now, this type of CVT was generally used in small cars whose engine generates only a low torque. Fig. 2(a) shows the case of low gear ratio, and Fig. 2(b) shows the case of a high ratio.

The toroidal CVT shown in Fig. 3 is another type of conventional CVT [5]-[11]. In the toroidal CVT, a power roller is placed between the input and output disks. The points of contact between both of input and output disks and the power rollers are changed as the inclination angle of the power roller is changed along the rotation axis by another exterior force in order to change the speed ratio. This type of CVT is used for a comparatively big type of vehicles with an engine that can generate high power and torque. Fig. 3(a) shows the case in the situation of a speed reduction gear ratio (low ratio), and Fig. 3(b) shows the situation of a multiplying gear ratio (high

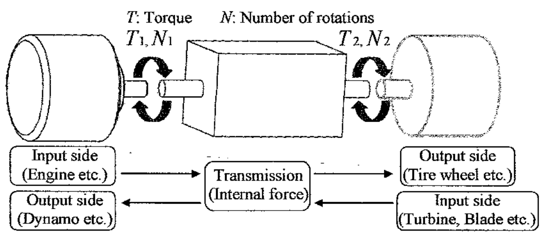

Fig. 1. Transmission principle