Tripple Cam Stepless Variable Transmission

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Abstract— There are several categories of CVTs in existence today, including traction, belt, and ratcheting types. Drives of these types, their attributes, and associated design challenges are discussed to frame the development of the Cam-based IVT. The operation of this transmission is kinematically similar to a planetary gear set, and therefore, its operation is described with that in mind including a description of the six major components of the transmission, those being the cam, followers, carriers, planet gears, sun gears, and one way clutches. A method was developed to select the most suitable inversion, gearing, and follower velocity for a given application.

Key words: CVT, IVT, CAD, CAE, GEARS

I. Introduction

A continuously variable transmission (CVT) is a system which allows a user to vary the angular velocity between an input and output progressively from one positive value to another. Unlike conventional transmissions, the selection of gears is not restricted to a finite number of ratios. An infinitely variable transmission (IVT), such as the Cam-based IVT presented here, is a particular type of CVT which can also achieve a transmission ratio of zero, commonly referred to as a geared neutral. These transmissions, which date back to at least 1877, are sometimes referred to as one of the "Holy Grails" of mechanical engineering, because firstly, they can transmit power at an infinite number of gear ratios, and secondly, it is extremely difficult to design and produce a transmission competitive with their non-continuously variable cousins. It is hoped that this work will contribute to the knowledge, understanding, and success of all continuously variable transmissions.

A. Problem Definition

There are many machines and mechanical units that under varying circumstances make it desirable to be able to drive at an barely perceptible speed , an inter mediate speed or a high speed. Thus an infinitely variable in which it is possible to get any desirable speed. Some mechanicals hydraulic and electrical devices serve as such stepless drives. However the torque Vs speed characteristics of these drives do not match that of stepless drives at increased driving torque at low speeds.

B. Solution

In many drives, it is desirable to be able to shift from one speed to another without stopping the machine and also be able to obtain any speed between the max and min. A design which meets these requirements is the triple cam stepless variable transmission.

II. Cam based infinitely variable transmission

In its simplest form, this transmission contains six unique components. The heart of this transmission is a centrally located three dimensional cammoid. It is sometimes referred to as simply "cam" but this is somewhat undescriptive as a cammoid has a continuously varying profile along its length. The cammoid is most often fixed to ground, but can also serve as the input or output. Around the cammoid are a number of followers. Each follower interacts with the cammoid through a spherical or ellipsoidal roller mounted on said follower. The followers are held to the cam surface when not under load by a return spring. The followers are rotatably mounted to one or two carrier plates, the third major unique component of the transmission. The carriers are used to support the followers as well as transmit the input and output torques in some inversions.

When designed to rotate, the carriers do so about the central axis of the cam. On each follower, is fixed a planet gear or pulley which meshes with a sun gear. The sixth and final unique component of the Cam-based IVT is a one way clutch located inside each of the planet gears or the sun gears. These clutches are responsible for rectifying the oscillations generated by the cam and followers and can be connected on the race opposite the sun gear to either the input, output, or ground depending on the inversion specified.

The shaft connected to this inner race of the sun gears is simply called the sun gear shaft & its purpose is to transmit torque from an external source to both the sun gears.

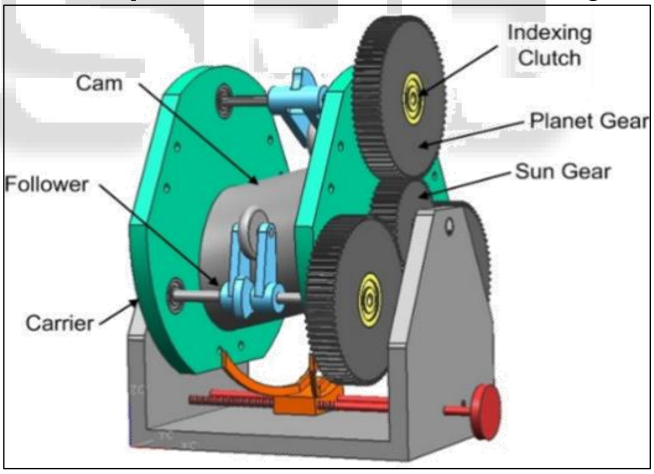

Fig. 1: Major components of a simplified representation of cam-based IVT

The Cam-based IVT is a unique transmission with many capabilities beyond that of other current ratcheting drives and IVT technologies such as the torroidal and belt driven types. Much like the torroidal drives, in which most if not all of the driving torque passes through a small contactregion, the entire reaction force to the driving torque of the Cam-based IVT is transmitted throughthe contact area between the rollers and cam. Therefore, this small region exhibits a very highHertzian contact stress which is proportional to the input torque.

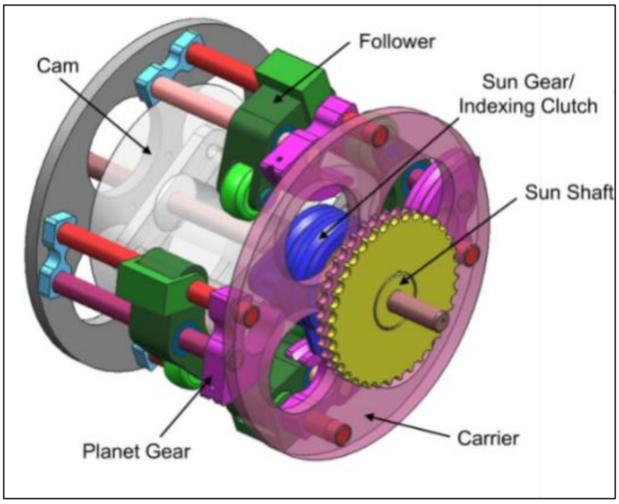

Fig. 1: complete prototype of cam based IVT

Utilizing a unique cable differential, which splits the input torque evenly between two followers, allowed for two active followers and therefore loaded rollers. Inverting the cam provided a larger radius of curvature and a more complimentary surface for the roller to follow. Both methods and their characteristics are presented here.

A. *Advantages*

1) Stepless variation of speed:- Any speed between Nmax to Nmin can be obtained . The conventional gives fixed speed ratios\ that too in steps.
2) Wide range of speeds Ratio:-The speed ratio can be varied one a wide range which is not possible in conventional gearbox where it is fixed speed ratio.
3) Compact size, easy of operation, low cost.
4) Singular control:-Entire range of speeds is covered by a single hand wheel control.

III. Conclusions

The seven major components the reader should be familiar with are the sun shaft, sun gears, planet gears, carrier, followers, cammoid, and one way clutches. Amongst these, the cammoid, carrier, and sunshaft can theoretically act as either the input or output for different inversions. The cammoid is heart of the transmission, essentially being a cam with a continuously changing profile alongits length. This component gives the transmission infinitely variable transmission ratios. The operation of the transmission was also presented, first as a simple cam/follower system withan attached gear train. In this inversion, the cam rotates as the input, causing the followers to oscillate out of phase with one another.

This is the simplest inversion of the transmission, and although some inversions are more difficult to visualize, it is important to remember that their operation is only an inversion of this simple system. Finally the inversion used for the majority of this work is described in which the sun shaft serves as the input, and the carrier as the output.

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