IJFEAT
INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY

Review Paper On Cone Ring Traction Drive

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***Abstract*—CVT's are used for reducing fuel consumption, requiring high efficiency. A transmission which can change through an infinite number of gear ratios between maximum value and minimum value by a continuously variable transmissions (cvt). This is different than other mechanical transmissions that have selected discrete gear ratios. The constant angular velocity is maintained by flexibility of cvt, which is beneficial for fuel economy. Small vehicles can maintain balance between fuel efficiency and cost of manufacturing. Motor scooters and snowmobiles use CVTs. Motor scooter and Snowmobile CVTs are rubber belt pulley CVTs. A belt driven design offers approximately 88% efficiency by enabling the engine to run at it's most efficient revolutions per minute (rpm) for a range of vehicle speeds. Thus this technique is useful to balance between fuel efficiency and the cost of manufacturing.**

***Index Terms*—CVT,Mechanical transmission,gear ratio**

I. Introduction

The introduction of new transmission concepts such as 6-speed stepped automatic, auto-shift manual and dual clutch transmissions places new challenges for a state-of-the-art CVT transmission concept [1].

A. Description of Kegel Ring Getriebe (KRG):

In comparison with other continuously variable transmissions (CVTs) this causes significant advantages in terms of manufacturing costs and efficiency. Basic Characteristics of the KRG Concept In order to achieve good vehicle driving dynamics, any kind of automatic transmission must have the capability to translate the driver's gas pedal input for a dynamic acceleration into a quick change of transmission gear ratio, but at the same time smooth torque transition. For the KRG concept, quick ratio changes require a high torque capability of the friction contact and the shortest possible delay of the involved dynamic systems. Any control function needed beyond the basic mechanical ratio change system, such as the hydraulic pressure control and very high power requirements for the gear change actuator of conventional CVTs, necessarily leads to unwanted delays in the shifting process. Thus, avoiding a hydraulic system and using an actuator system with low "shifting" forces were decided very early during the KRG concept development as the basic means to achieve a sporty performance feeling. Today's modern engine fuel island maps are getting "flatter", which means that CVT transmissions can only take benefit of their larger ratio range, if the associated improvement in the engine operating point is not compensated by a low transmission efficiency, particularly at light loads. The demand for applying clamping forces to the power transmission elements has a decisive influence here, because these force levels in friction-wheel transmissions are quite high and must also be applied constantly. As an ideal solution combined torque sensor and actuator was designed for the KRG, as described below. For automotive mass production, robust design and low manufacturing costs are imperative requirements. The design of the KRG variator system is kept very simple and insensitive to manufacturing tolerances. Cost estimations have shown a great potential compared to conventional CVT concepts [3].

B. The KRG Design:

The basic components of the KRG variator, such as rollers, clamping and adjustment unit are all purely mechanical, as described in more detail below [2].

- *Variator*

The variator is built up by an input cone, an output cone and a transfer ring which can be positioned around the input or output cone. By changing diameter and angle of the cones, start-up and overdrive ratio as well as the ratio spread can easily be adapted to vehicle requirements and installation space [4].

- *Clamping Unit*

The required clamping force is obtained through the axial displacement of the output cone. A mechanical torque sensor based on a ball and ramp system, transforms the output torque into an axial pressure force with very high efficiency. By locating this mechanism in the torque path from the output shaft, all load changes such as road induced torque peaks are automatically detected and converted corresponding axial force. The combination of sensor and actuator in a simple mechanical system avoids the need of expensive sensor technology and electronic / hydraulic control systems commonly found in conventional CVTs [6].

• *Adjustment Unit*

For ratio change, the adjustment unit moves the ring into its new position by a steering motion. Similar to a bicycle, extremely quick lateral movements are possible with low steering forces, by combining the rotation of the ring and a steering angle around the vertical axis. Inside the KRG the steering of the transfer ring is initiated by an angular movement of the control frame. This frame is actuated by a servo motor outside of the transmission, such that all electrical and electronic components are not in contact with fluids. The power of the servo motor is only required to overcome the inertia of the control frame and ring during the steering motion, whereas the energy for the ratio change itself is provided by the cone rotation. During constant ratio driving, the control frame is kept at its neutral position requiring no servo motor power [5].

Contact Point and Traction Fluid

All CVT-concepts based on a friction system use one or more points for the power transfer. The power capacity of the friction system is determined by the normal load in the contact point and the friction (traction) coefficient of the tribological system. While the maximum normal load is limited by the permissible bearing loads and maximum allowable contact stress, extensive research work has shown great improvement potential, if the function of the variator fluid can be reduced to torque transfer via shear forces in the oil. To avoid the critical conflict between the contradicting requirements of friction in the contact point and lubrication for the bearings in conventional CVT designs, the KRG uses two different fluids in separated chambers. Whilst the bearings are provided with a commercial lubricant, a specially developed traction fluid is used for power transmission in the variator. The traction oil is supplied to the friction contact by splashing from the output cone dipping into the fluid level. Thus, the friction fluid needs no pumpability at low temperatures. The optimization of this oil can be focused on price, traction coefficient and temperature stability. Compared with conventional CVT fluids, an increase in friction value of more than 50% has been achieved during development and appears to have not yet reached the limits of feasibility. This friction value increase translates directly into a significant improvement of the power density and package of the transmission [8].

Vehicle Installation

The cone-ring concept has been developed for both front (FWD) and rear wheel drive (RWD) applications. Whereas RWD installations have been investigated in various studies, the present emphasis in development is on the FWD derivatives because of their higher potential market volume. Due to the opposite location of the large cone diameters, the KRG has a small distance between variator input and output shaft and as a result a small centre distance between transmission input and output shaft. For an engine torque up to 180 Nm, axle distances around 160 mm are possible with a start-up ratio greater than 16, which covers the majority of current FWD installations.

Starting Device

In principle, the KRG can be driven with a converter, wet clutch or dry clutch. While an automatic dry clutch makes sense for small vehicle applications due to cost pressures and lower comfort demands, comfort-oriented vehicles tend to be equipped with a converter.

Control System

The control strategy is divided into the different hierarchies of low level internal transmission control and high level drive train control strategy. While the high level logic selects the appropriate transmission ratio set point in line with performance and fuel economy requirements for the particular driving condition, the low level control applies this ratio in a closed loop control for the electromechanical actuation system. The shorter the time delay is to respond to step changes in transmission ratio set point, the more freedom is available for the “right” driving strategy. This strategy is highly dependent on regional customer preferences as well as the OEM’s “brand identity”. The current KRG vehicle demonstrator with a 85 kW gasoline engine offers three driving modes, an economy CVT-mode with emphasis on vehicle fuel consumption, a sporty CVT-mode with high acceleration performance, and a manual 6-speed tip-mode operated by the driver. The control system design of the KRG and the launch clutch have been designed by using MATLAB SIMULINK and dSPACE, Together with the models for the vehicle and the power train, this approach enables a complete CAE based dynamic system simulation and optimization before the first hardware tests.

II. Literature Review

The literature review has been carried out in the areas of cone ring traction drive used for numerous power utility industrial applications and many more.

1. Konstantin Ivanov [1] addresses Motor-wheel of transport machine demands a using of step gear box. Necessity of the controlled coordination of forces on different wheels takes place. Recently the theory of adaptive continuously variable transmission (CVT) in the form of gear differential with mobile closed contour has been developed. The patents on the simplest adaptive transmission were created. Such transmission allows creating the small-size adaptive motorwheel with ideal adjustable to conditions of joint movement of all wheels of the transport machine without any control system. The work is devoted to working out of self adjusting motor-wheel on the basis of theory of mechanisms and machines.

2.Wisam M. Abu-Jadayil and Mousa S. Mohsen [2] addresses the friction drive speed reducer proposed by Flugrad and Qamhiyah in 2005 was mainly investigated in this paper. That self actuating traction drive uses six intermediate cylindrical rollers to transmit motion. Those rollers fail by fatigue. So, this research built a numerical simulation model to find the optimum size of those rollers which give the least contact stresses and so the longest fatigue life. Then those rollers were replaced by hollow ones.

3. Ryan R. Dalling [3] addresses A Positive Engagement, Continuously Variable Transmission (PECVT) allows for a continuously variable transmission ratio over a given range using positively engaged members, such as gear teeth, to transmit torque. This research is an investigation of PECVTs to establish a classification system and governing principles that must be satisfied for an embodiment to overcome the non-integer tooth problem. Results of an external patent search are given as examples of different concepts and PECVT embodiments that have been employed to negate the effects of the non-integer tooth problem.

II. METHODOLOGY

i. Traction Drive Selection-The speed reducer proposed here is designed so that the configuration of the rolling elements creates the needed normal force in response to the torque exerted back on the system by the downstream loading. Thus the device is self-actuating.

ii. Continuously Variable Transmission Fluid- Torco CVT Fluid is 100% Synthetic Continuously Variable Transmission (CVT) fluid. Torco CVT Fluid is specifically designed to meet multi-vehicle OEM specifications in severe operating conditions encountered in high performance street and racing applications. It is formulated using 100% synthetic base oils and a specifically balanced additive combination to provide high oxidation stability, excellent foam resistance, corrosion and wear protection under extreme loads, high operation temperature and high speed conditions. Torco CVT Fluid offers superior shear resistance, unmatched chain and push belt protection and clean operation for extended component durability. Torco CVT Fluid also compounded with a friction-modifying additive to provide smooth and efficient transmission [8].

iii. Power required for achieving the output torque will be 600KW and the input speed of the shaft will be 15000rev/min with an input torque of 600 Nm.

iv. A ratio of 2.5:1 is kept so that any speed reducing or speed-increasing ratio can be achieved.

v. For better torque transmission the output cone is provided with a helical spring so that the output cone can be moved axially.

III. WORKING

Motor is connected to the Input Cone Shaft via Reduction Pulley and Belt arrangement. The input cone shaft is integral and is mounted in ball bearings in the LH & RH bearing housing respectively. The output cone shaft is mounted in ball bearings in the LH & RH bearing housing respectively and output cone is keyed to it. The output cone can slide axially and the displacement is governed by locknut. The preload in the system is maintained by the helical compression spring and the thrust bearing arrangement. The variator cone ring connects the two cones and it freely rotates in ball bearing mounted in the ring holder. The speed changing arrangement comprises of the speed adjuster nut mounted on the speed adjuster screw held in ball bearings in the bearing housings 1&2 respectively.

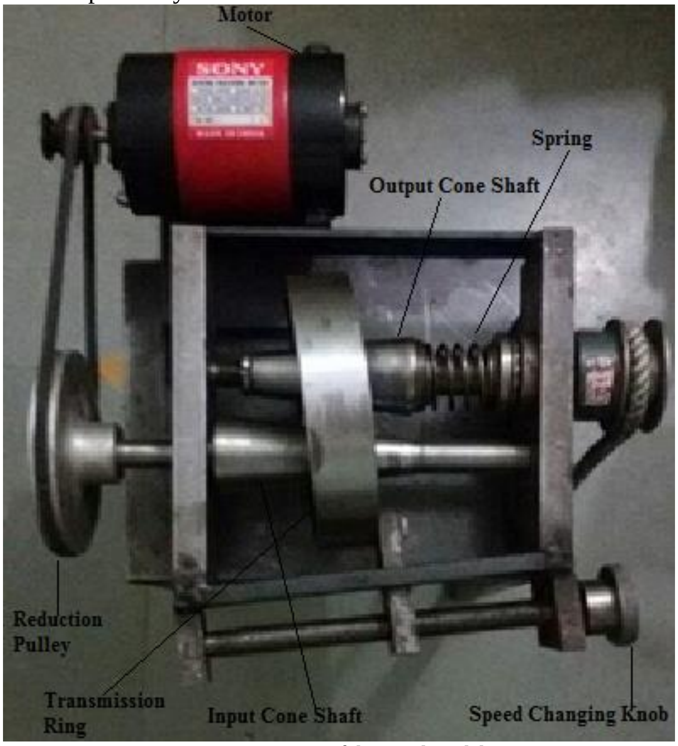

Fig1. Top view of designed model

A) General: When motor is started it drives the input cone shaft via open belt drive. The input cone transmits this motion to the variator cone ring which in turn drives output cone and thereby the output shaft [7].

B) Speed Changing:

The speed changing knob when turned rotates the speed changing screw thereby effecting the translation of the nut and thereby that of the ring holder and the variator cone ring. This translation changes the contact ratio between the two cones thereby effecting speed change. Minimum 60 different speed changes are possible considering the effective slant edge length on either cone. The speed changes are continuous and can be made without stopping or disconnecting the drive [9].

C) Torque Adjustment:

The output cone can slide axially and the displacement is governed by locknut. The preload in the system is maintained by the helical compression spring and the thrust bearing arrangement. The variator cone ring connects the two cones and hence when the output cone is axially displaced it changes the radial load and thereby the torque transmitted [10].

IV. CONCLUSION

CVTs can compensate for changing vehicle speeds, allowing the engine speed to remain at its level of peak efficiency. This improves fuel economy and by effect, exhausts emissions. CVTs require less space when compared with the gear box system. The operation is quite inherent as the traction drive is between nearly perfect concentric circles with component roundness and concentricity. Because of design ingenuity and use of special bearing races, virtually any speed reducing or speed-increasing ratio can be achieved. CVTs operate smoothly since there are no gear changes which cause sudden jerks. Many small tractors for home and garden use have simple hydrostatic or rubber belt CVTs.

V. Acknowledgement

I have great pleasure in expressing my gratitude to my project guide Prof. N.N. More for guiding us for this project. I am also thankful to all staff members of SKN-SITS, Lonavala for their direct and indirect help.

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