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A Review of Transmission System for Performance of CVT

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Abstract

The constant rise in fuel prices on a day to day basis, maximum performance with minimum compromise on the front of fuel economy and emissions is highly desirable and expected from a vehicle's transmission system. These friction drive CVTs were common in automotive use until engines capable of producing higher torques became common and necessitated the move to geared, fixed-ratio transmissions capable of high torque transfer and having better wear characteristics than friction dependent CVTs. Only in the past few years, with the advent of advanced materials and technology, have friction dependent CVTs returned to commercial application in the automotive industry. To provide a foundation and motivation for the research presented, this chapter first presents a definition of a continuously variable transmission.

Keywords—CVT, Ball, traction drive, performance

I. INTRODUCTION

The primary function of a transmission is to transmit mechanical power from a power source to some form of useful output device. Since the invention of the internal combustion engine, it has been the goal of transmission designers to develop more efficient methods of coupling the output of an engine to a load while allowing the engine to operate in its most efficient or highest power range. Conventional transmissions allow for the selection of discrete gear ratios, thus limiting the engine to providing maximum power or efficiency for limited ranges of output speed. Because the engine is forced to modulate its speed to provide continuously variable output from the transmission to the load, it operates much of the time in low power and low efficiency regimes.

A continuously variable transmission (CVT) is a type of transmission, however, that allows an infinitely variable ratio change within a finite range, thereby allowing the engine to continuously operate in its most efficient or highest performance range, while the transmission provides a continuously variable output to the load. The development of modern CVTs has generally focused on friction driven devices, such as those commonly used in off-road recreational vehicles, and recently in some automobiles. While these devices allow for the selection of a continuous range of transmission ratios, they are inherently inefficient. The reliance on friction to transmit power from the power source to the load is a source of power loss because some slipping is possible.
It transmits an uninterrupted power to the wheels and mostly runs engine at constant power as shown in Fig.1

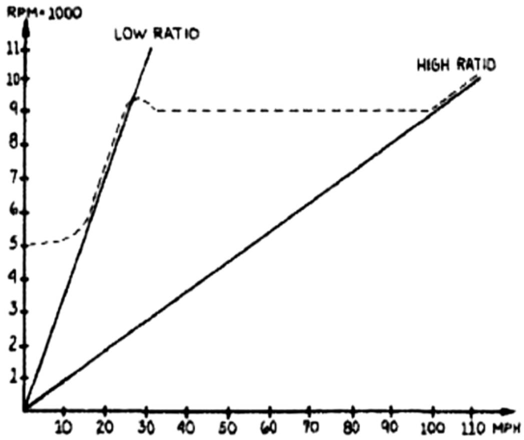

Fig.1 CVT Curve for Engine Speed and Velocity of the Vehicle

There are many kinds of CVTs, each having their own characteristics, e.g. Spherical CVT, Hydrostatic CVT, E-CVT, Toroidal CVT, Power-split CVT, Belt CVT, Chain CVT, Multi-Ball-type toroidal CVT, Milner CVT etc.[4,5] Varying the axial distance between the sheaves of each pulley leads to the belt to move radially outward or inward, producing a continuous range of speed ratios safely, as shown in Fig. 2

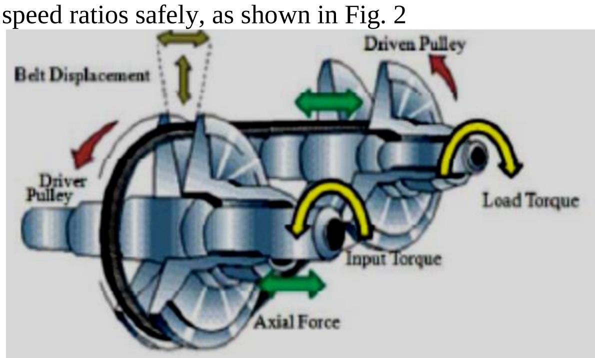

Fig. 2 Model of metal V-belt CVT.

II. PRINCIPLE OF OPERATION OF SINGLE BALL TRACTION DRIVE

There are many machines and mechanical units that under varying circumstances make it desirable to be able to drive at barely perceptible speed, an intermediate speed or a high speed. Thus an infinitely variable (step less) speed variation in which it is possible to get any desirable speed. Some mechanical, hydraulic, drives serve as such stepless drives. However the torque versus speed characteristics of these drives does not match torque at low speeds. the major components of the drive are steel ball (1) positioned between two axially displaced hollow cone discs (2 & 3) and acts as a power transmission element.

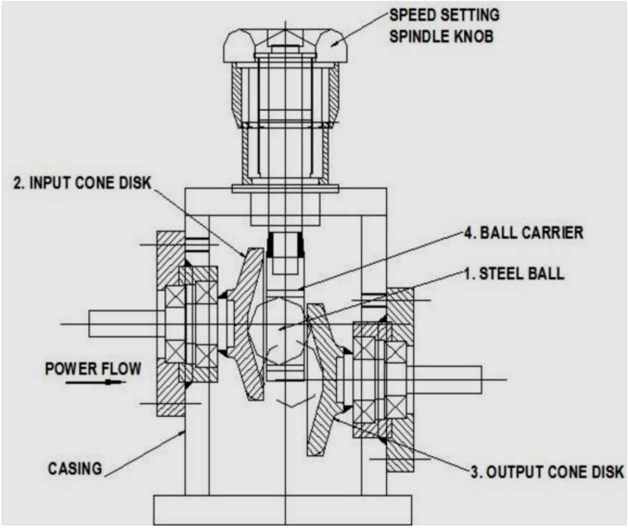

Fig.3 Principle of Operation of Single Ball Traction Drive

When the load is applied, the transmission ball is pulled into a triangle formed by the two hollow cone disks by an amount equal to the elastic deformation of the parts under load. Thus the contact pressure is directly proportional to the output torque. Clockwise or counter clockwise rotation is permissible. The output speed of the drive is infinitely variable and it is achieved by adjusting the position of the steel ball rotating the speed-setting spindle knob (4).

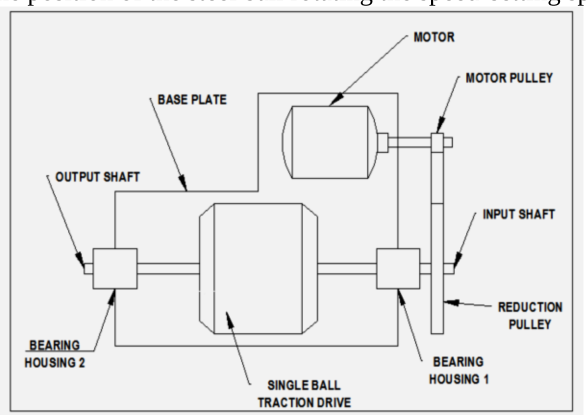

Fig.4 Test Rig for the Analysis of Performance characteristics

In the upper adjustment position ratio of 3:1 reduction is created between input and output shaft. In the lower adjustment position the ratio is 1:3. The total speed range covered is up to 9:1. For a speed range of 6:1, higher input horse power is possible since the output horse power is determined by the lower output speed.

The test rig required for the Analysis of Performance characteristics can be tentatively constructed as shown in Fig. 4.

III. PERFORMANCE CHACTERISTICS OF CVT

A. CALCULATION OF THE DESIGN STRESS AND VELOCITY OF THE GEAR

The four sprocketswithin the secondary reduction box have 10, 48, 12 & 30 teeth respectively. The inermidiate gear ratio have found to be4.8 :1 using following equation :

Intermidiate gear ratio $=\frac{n_2}{n_1}$

Where n_2 is the no of teeth on gear 2 and n_1 is no of teeth on gear 1. The final gear ratio can be determined to be 12: 1 using the equation :

Final Gear Ratio $= \frac{n_2 n_4}{n_1 n_3}$

The CVT specified ratio 3.38 for low and 0.54 for high. The theoretical wheel diameter is 0.53. these value leads to calculation of gear ratio with CVT using following equation :

Gear ratio with CVT =

(Final Gear Ratio) . (CVT Ratio)

The axel rotational velocity were calculated using following equation :

$$\text{Axle Rotational Velocity} = \frac{Enginevelocity}{GearRatioWithCVT}$$

The equation for calculating wheel velocity is

Wheel velocity = π . d

Where d is wheel diameter in m , axle velocity in rpm. The input axle rotational velocity was calculated using the following equation

$$\text{Input Axle Velocity} = \frac{EngineRotationalVelocity}{HighCVTRatio}$$

B . DETERMINATION OF CVT PULLEY RADIUS

Normal CVT have the speed ratio between ranges of 0.5 to 2.0. 0.5 is the minimum value under-drive ratio that a normal CVT can achieve. Meanwhile, 2.0 is the maximum value of over-drive ratio condition. This kind of ratio may conclude that the design of CVT system should include three stages as reference point and must within the range of 0.5 to 2.0.

Two assumption need to be considered:

i) No belt elongation occurs during operation

ii) Effective line is continuous along the pitch line

$$L = R_p\beta_p + R_s\beta_s + 2\sqrt{X^2 - (R_s - R_p)^2}$$

where ,

R_P- radius of belt at primary pulley
R_S- radius of belt at secondary pulley
β_P- angle of lap on a primary pulley
β_S- angle of lap on secondary pulley
X - pulley centre distance
A - angle of belt at straight line

IV. CONCLUSION

Review on performance strategy for single ball contineous variable transmission (CVT) has been discussed, the literature reviewed sggested that there is concidersble change in the type of CVT model that have been used for performance development.A contineous

Variable transmission is a promising automotive transmission techenology that can provide higher fuel economy, reduce emission and better vehicle performance. Further, new reasearch should be investigated in the performance of CVT design and configuration.

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