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Design and development of continuous variable transmission with launch gear

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ABSTRACT

A transmission is a machine in a power transmission system, which provides a controlled application of power. Often the term transmission refers simply to the gearbox that uses gears and gear trains to provide speed and torque conversions from a rotating power source to another device. The transmission also provides a reverse gear resulting in backward motion of the vehicle. CVT or continuously variable transmission provides an automatic feature for changing the gear ratio depending upon different engine load conditions. Even being an automatic transmission, CVT consists of lesser moving parts and is simpler and compact design. Metal belt and variable pulleys, one of the most popular kinds of CVT that are used in the automobiles widely because it can provide better acceleration because of higher low ratio and better fuel consumption because of less over drive ratio. Despite providing such advantages, CVT generates less torque at lower engine RPM. This is due to slipping of the belt over the tapered surfaces of the variable pulley. Therefore, a mechanism with a launch gear driving the pulleys to reduce belt slip is to be introduced and developed to overcome this problem increasing torque at lower rpm.

Keywords— *Transmission, CVT, Launch gear*

1. INTRODUCTION

The automobile transmission system can be classified into two types including manual transmission and automatic transmission. In the case of the manual transmission system, the vehicle is driven with the assistance of gearshift and foot clutch. The other components, which are used in this process, are flywheel, pressure plate and ring gears. In case of the automatic transmission system, the gears are changed automatically corresponding with the vehicle's speed. The basic components essential for this process are modulator, torque converter, planetary gears, governor, computer, seals and hydraulic designs. There are different types of automatic transmissions like Automated Manual Transmission (AMT), Dual Clutch Transmission (DCT), Automatic Transmission (AT) and Continuous Variable Transmission (CVT).

A Continuously Variable Transmission (CVT) is an automated, step-less power transmission system, which can help the combustion engine to be operated at its highest efficiency points. With a CVT, engine speed and vehicle speed are no longer connected by a series of discrete ratios. Instead, they can function independently across a wide and step-less band according to engine characteristics and performance requirements. The advantages of this infinite ratio selectivity are enormous. Most obvious in the IC engine application is that the engine can be loaded into its most fuel-efficient region at cruising speeds, then allowed to accelerate into its region of greatest output when peak power is needed, regardless of vehicle speed.

2. SCOPE OF THE PROJECT

To overcome the problems or drawbacks of the CVT automakers doing research on it. In this project, we try to overcome these two major drawbacks of CVT. The drawbacks can be overcome by adding a gear arrangement between the engine shaft and the output shaft. This will increase starting torque or torque at lower engine RPM and overall speed range of CVT. Simultaneously it will decrease belt wear and tear and CVT components life gets an increase.

By this project, vehicles can get better efficiency from Continuous Variable Transmission. And also because of less wear of CVT components, the maintenance life of the vehicle will be increased and the main advantage will be an increase in fuel economy.

3. OBJECTIVES OF THE PROJECT

- To increase the speed range of conventional CVT.
- To increase torque at lower RPM in CVT.
- To design and develop launch gear mechanism.
- To develop a new actuating mechanism to operate the launch gear.

4. SELECTION OF THE MATERIAL

To prepare any machine part, the type of material should be properly selected by considering design, safety, and following points:

(a) Suitability of the material for the required components.
(b) Suitability of the material for the desired working conditions.
(c) Availability of materials.
(d) Cost of the materials.

In addition to the above-mentioned factors, the other mechanical & physical prosperities should be considered while selecting material for fabrication.

4.1 Materials properties

A material's property (or materials property) is an intensive property of some material, i.e. a physical property that does not depend on the amount of the material. These quantitative properties may be used as a metric by which the benefits of one material versus another can be compared, thereby aiding in materials selection. A property may be a constant or may be a function of one or more independent variables, such as temperature. Materials properties often vary to some degree according to the direction in the material in which they are measured, a condition referred to as anisotropy. Materials properties that relate to different physical phenomena often behave linearly (or approximately so) in a given operating range. Modeling them as linear can significantly simplify the differential constitutive equations that the property describes.

(a) Strength: It is the ability of a material to resist the externally applied forces without Breaking or yielding.

(b) Stiffness: It is the ability of a material to resist deformation under stress. The modulus of elasticity is the erasure of stuffiness.

(c) Elasticity: It is the property of a material to regain its original shape after deformation when external forces are removed.

(d) Malleability: The ability of a material to be reshaped in all directions without cracking our technology technician demonstrates the 'malleability' of a material by heating a piece of mild steel until it is red hot. He then beats it with a large forging hammer to reshape it. Because of the high temperature it reaches while heating the steel becomes malleable, it can be reshaped permanently. It often heats up steel, because he likes the color and it matches his complexion after he has run up the stairs.

(e) Toughness: A characteristics of a material that does not break when receiving a blow or under a sudden shock. Our technology technician demonstrates the 'toughness' of material by hitting a piece of material to see if it will break or shatter. It has been known to test the authentic Chinese Ming Dynasty pottery with the same technique. This is why he is often arrested in Museums and has been banned from the local Antique dealers.

(f) Hardness: The ability of a material to resist scratching, wear and tear and indentation. Our technology technician, dressed in a kilt, slides along the floor to see if it will scratch. It will be considered too hard wearing if it resists scratching.

(g) Fatigue Ratio: The dimensionless fatigue ratio of the stress required to cause failure after a specific number of cycles to the yield stress of a material. Fatigue tests are generally run through 10^7 or 10^8 cycles. A high fatigue ratio indicates materials which are more susceptible to crack growth during cyclic loading.

(h) Creep: In materials science, creep is the tendency of a solid material to move slowly or deform permanently under the influence of stresses. It occurs as a result of long-term exposure to high levels of stress that are below the yield strength of the material. Creep is more severe in materials that are subjected to heat for long periods and near their melting point.

(i) EN8 (Medium Carbon steel): EN8 carbon steel is a common medium carbon and medium tensile steel, with improved strength over mild steel, through-hardening medium carbon steel. EN8 carbon steel is also readily machinable in any condition.

Table 1: Contents of EN8 material

Composition	Carbon	0.36-0.44%
	Manganese	0.60-1%
	Sulphur	0.050 Max
	Phosphorus	0.050 Max
	Silicon	0.10-0.40%
	Iron	Remainder

5. CAD MODEL

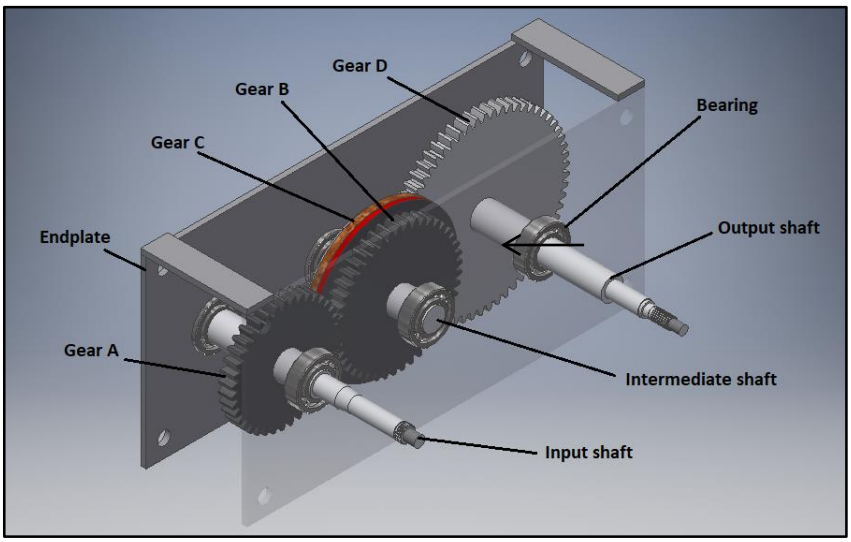

Fig. 1: CAD Model

6. COMPONENTS AND FUNCTIONS

(a) Gear A: It is made up of EN8 (Medium Carbon Steel) material with 39 teeth and 117 mm pitch circle diameter mounted on the input shaft of CVT. The power produced from the engine is transmitted through this gear.

(b) Gear B: It is gear which is paired with Gear A and mounted on the intermediate shaft. It is also made up of EN8 (Medium Carbon Steel) material with 45 teeth and 135 mm pitch circle diameter. It is modified to act as a friction surface by adding a metal plate on it.

(c) Gear C: It is gear which free to rotate and placed on the intermediate shaft. It is also made up of EN8 (Medium Carbon Steel) material with 24 teeth and 72 mm pitch circle diameter. It is modified to act as a friction surface by adding a clutch plate on it.

(d) Gear D: The It is gear which is paired with Gear C and mounted on the output shaft. It is made up of EN8 (Medium Carbon Steel) material with 62 teeth and 186 mm pitch circle diameter.

(e) Input shaft: This shaft is connected to the engine. CVT input variator and Gear A is mounted on this shaft. It is made of EN8 (Medium Carbon Steel) material.

(f) Output shaft: It is a shaft which connected to output drive. CVT output variator and Gear D is mounted on this shaft. It is made of EN8 (Medium Carbon Steel) material

(g) Intermediate shaft: It is a shaft which intermediates between input and output shaft. Gear B and Gear C is mounted on this shaft. It is made of EN8 (Medium Carbon Steel) material.

(h) Endplates: In order to assemble each and every component two plates of 445mm x 205mm dimension were selected to support shaft and to form a frame for the entire system.

(i) Bearings: For free rotation of shafts bearings are provided at end of each shaft. Here 6205 Bearings are used.

(j) Release mechanism: It consists of a lever and release fork. Release fork is connected to the lever and rest on the Gear C.

7. CALCULATIONS

CVT:

CVT input pulley diameter: *76mm*

CVT output pulley diameter: *135mm*

$$Ratio: = \frac{Output}{input} = \frac{135}{76} = 1.78$$

Now assume input torque is *1Nm*

$$Output\ Torque\ = \ Input\ torque\ \times\ Ratio$$
$$= 1*1.73$$
$$= 1.73\ Nm$$

Gear drive:

Overall gear ratio= *3*

Assume input torque is *1Nm*

$$Output\ Torque = \ Input\ torque\ \times\ gear\ ratio$$
$$= 1*3$$
$$= 3\ Nm$$

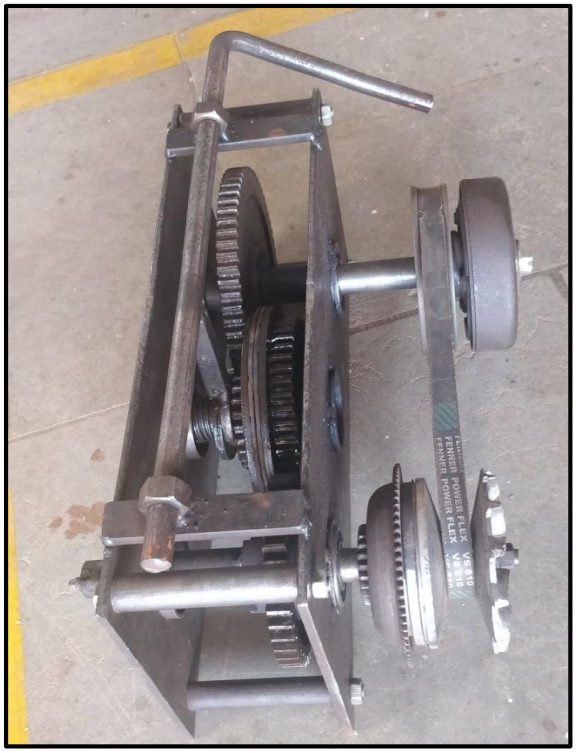

Fig. 2: Working of CVT with launch gear

7. RESULT

Fig. 2: Results

S no.	RPM	Input torque	Output torque	
			Without launch gear	With launch gear
1	1300	2.13 Nm	3.68 Nm	6.39 Nm
2	1400	2.29 Nm	3.96 Nm	6.87 Nm
3	1500	2.45 Nm	4.23 Nm	7.35 Nm

8. CONCLUSION

The new transmission works just like a regular CVT, though it employs a single Launch Gear, which is like the first gear in a conventional transmission, or the "easy" gear on a bicycle. Engaged when the vehicle is at rest, Launch Gear is used solely to help the vehicle accelerate up to speed more quickly and efficiently from a stop. Once the vehicle has reached a speed where the CVT transmission is more efficient, the launch gear is disengaged and the transmission functions like a CVT.

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