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# Cone Type CVT with High Speed Variations

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**Abstract—** This paper describes the design and development of power transmission through manual CVT. This design simplifies the transmission of power from rotary motion and also over comes the complexity of changing the speed ratios of pulleys and gears. The main purpose of this design is to attain 'n' number of speed ratios between designed limit. This contrasts with other mechanical transmissions that offer a fixed number of gear ratios. The flexibility of a CVT allows the input shaft to maintain a constant angular velocity. Here two conical component having required roughness is used. Power is transmitted through belt. This belt can be moved along the axis of conical components. Thus different speed ratio can be attained easily. This design can be applied in automobiles which has more efficiency when compared to automatic CVT.

**Index Terms**— Cone pulleys, V-belt, Flat belt, CVT, MS plates.

## 1 INTRODUCTION

IN In the last decades, a growing attention has been focused on the environmental question. Governments are forced to define standards and to adopt actions in order to reduce the polluting emissions and the green-house gasses. To reduce vehicles" gas emissions in relatively short times, a great deal of research has been devoted to find new technical solutions, which may improve the emission performances of nowadays internal combustion (IC) engine vehicles.

A very good solution may be that of using a CVT which is able to provide an infinite number of gear ratios between two finite limits. CVT transmissions are even potentially able to improve the performances of classical IC engine vehicles, by maintaining the engine operation point closer to its optimal efficiency line. Several studies have shown, indeed, that CVTs may improve the fuel savings and reduce the vehicle polluting emissions. For instance, a middle class CVT car may achieve fuel savings of about 10% in comparison to the traditional manual stepped transmission .

A CVT is a transmission which can gradually shift to any effective gear ratios between a set upper and lower limit. In contrast, most transmissions equipped on production cars have only 4-6 specific gear ratios that can be selected. The almost infinite variability of a CVT allows the engine to maintain a constant speed while the vehicle increases in velocity. This can result in better vehicle performance if the CVT is shifted such that the engine is held at the RPM that it runs most efficiently at and/or produces the most power .

Physical limitations of strength and friction have in the past restricted the CVT transmission torque handling capabilities to light-duty applications such as lawnmowers, ATVs, and snowmobiles. There was very little desire to develop them to their full potential. However, a renewed public outcry for improved vehicle efficiency combined with advancements in lubricants and materials have sparked new interests in CVTs. They have now been proven to support the torque requirements for production vehicles, buses, heavy trucks, and earth-moving equipment .

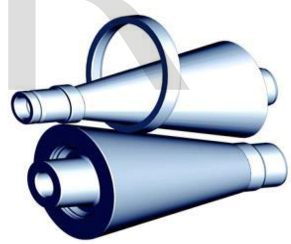

fig1.Cone CVT

A cone CVT varies the effective gear ratio using one or more conical rollers. The simplest type of cone CVT, the single-cone version, uses a wheel that moves along the slope of the cone, creating the variation between the narrow and wide diameters of the cone. The more sophisticated twin cone mesh system is also a type of cone CVT.

In a CVT with oscillating cones, the torque is transmitted via friction from a variable number of cones (according to the torque to be transmitted) to a central, barrel-shaped hub. The side surface of the hub is convex with a specific radius of curvature which is smaller than the concavity radius of the cones. In this way, there will be only one (theoretical) contact point between each cone and the hub at any time.

A new CVT using this technology, the Warko, was presented in Berlin during the 6th International CTI Symposium of Innovative Automotive Transmissions, on 3–7

ISSN 2229-5518

December 2007. A particular characteristic of the Warko is the absence of a clutch: the engine is always connected to the wheels, and the rear drive is obtained by means of an epicyclic system in output. This system, named "power split", allows the engine to have a "neutral gear". When the engine turns (connected to the sun gear of the epicyclic system), the variator (i.e., the planetary gears) will compensate for the engine rotation, so the outer ring gear (which provides output) remains stationary.

## 2 Problem Statement

The performance of the vehicles depends on so many factors and one of it is the type of transmission. Nowadays, there are three types of transmission being used all around the world that effect the engine and each of it has their own advantages and disadvantages. But the best or ideal transmission for the vehicle still not exist and there are too many space for improvement for researcher to find the perfect one and to make sure the performance of the vehicle at the high level.

Manual transmission is familiar and widely used in passenger car at this age.CVT have become increasingly popular in the automotive marketplace in the past decade. Normally, the CVT is used in heavy vehicles such as trucks, buses and etc. This is because the CVT can provide high power and torque to facilitate in controlling of heavy vehicles. So, Manual and CVT transmission have their own advantages and of one of their advantage is better in performances.

## 3 Objective

The concept for the transmission design using inverted cone-shaped gears and a reinforced belt. The mechanism works by moving the reinforced belt up and down inverted cones during rotation to provide a changing set of gear ratios. The belt could be moved using a screw-based mechanism or lever that is either user controlled or factory set. The transmission has a reduced number of parts compared to a traditional transmission system with finite gear ratios.

The inverted cone-shaped gears provide a large amount of gear ratios for smooth transitions, which is important for the low-end torque required for initial tilling. The reverse mechanism involves a sliding set of gears that changes the direction of the driveshaft for fine reversing. If the torque upon reversal is too high for the gear teeth, then additional reverse assemblies can be added to reduce stresses on the teeth. The inverted cone+belt and reverse assembly concepts would be placed below the motor and above the current transmission assembly in a custom housing.

## 4 Design Calculation

Tapered Components (D) = 110mm
(d) = 60mm

### 4.1 V- Belt

The basic formula for belt friction is

$T_1/T_2 = e^{\mu\theta \operatorname{cosec}\beta}$

where $\theta$ = 3.14 rad; ($\theta$ - inclined angle)
$2\beta$ = 20 degree; ($\beta$ - angle)
$\mu$ = 0.1; ($\mu$ - static friction)
V = 2.87 m/s (v - velocity)
$T_1 = e^{0.1 \times \pi \times \operatorname{cosec}\beta} \times T_2$
$T_1 = 6.099T_2$

Power is given by,
$P = (T_1 - T_2) \times v$
$0.33 \times 10^3 = (6.099\,T_2 - T_2) \times 2.87$
$\mathbf{T_2 = 22.55\ N}$
$T_1 = 6.099 \times 22.55$

The tension in the belt,$\mathbf{T_1 = 137.53\ N}$

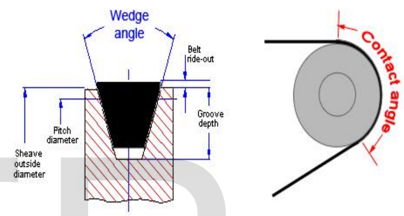


fig 2 - Dimensions of V-Belt

### 4.2 Flat Belt

The basic relation for belt friction is,
$T_1/T_2 = e^{\mu\theta}$
where $\mu$ = 0.2 ($\mu$ - static friction)
$\theta$ = 3.14 rad ($\theta$ - inclined angle)
$T_1 = 1.873\,T_2$

Power is given by,
$P = (T_1 - T_2) \times V$
$0.33 \times 10^3 = (1.873T_2 - T_2) \times 1.22$
$\mathbf{T_2 = 309.53\ N}$
$T_1 = 1.873 \times 309.53$
$\mathbf{T_1 = 579.76\ N}$

### 4.3 Speed given to the driver cone

The speed ,
$N_1$ = 1420 rpm
$N_1/N_2 = d_1/d_2 = 1420/N_2 = 254/38.1$
$N_2$ = 213 rpm

### 4.4 Driven Cone speed at Initial position

$N_3/N_4 = d_2/d_1$
$213/N_4 = 110/60$
$N_4$ =116rpm

ISSN 2229-5518

**Obtained speed range = 274rpm**

### 4.5 Driven Cone speed at Final position

$$N_3/N_4 = d_2/d_1$$
$$213/N_4 = 60/110$$
$$N_4 = 390 \text{ rpm}$$

## 5 Description of Components

1. A pair of cone pulleys
2. Groove pulley
3. Plated shafts
4. Motor
5. Flat belt
6. V-belt
7. Slider mechanism
8. Rollers
9. Frame
10. Bearings
11. Tachometer
12. 230V AC Supply
13. Fasteners



fig3 .Speed Ratio

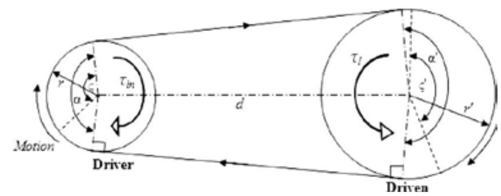


fig4 .Mechanism

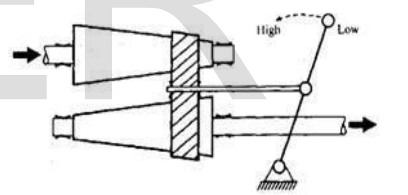


fig5.Belt and Lever mechanism

TABLE 1

CHARACTERISTICS OF MOTOR

| | |
|---|---|
| Motor Speed | 1420 rpm |
| Motor Type | AC Motor |
| Power of Motor | 0.33 KW |
| Torque of Motor | 2.2192 Nm |
| Direction | Reversible |
| Voltage | 230 volts |

TABLE 2

CHARACTERISTICS OF BELT DRIVES

| Characteristics | V-belts | Toothed belts |
|---|---|---|
| Characteristics | 12 | 11 |
| Maximum velocity ratio | | |
| Maximum belt speed(m/s) | 25 | 80 |
| Slip | 1 to 5% | Nil |
| Tension | Less | Very less |
| Shock resistance | Good | Fair |
| Resistance to wear | Fair | Good |
| Dressing | Not required | Not required |

## 6 Fabrication and Working

When the AC power supply is given to the motor, the setup starts rotating. Initially the belt is left side i.e., in smaller diameter of driver pulley and larger diameter of driven pulley. Use the tachometer and measure the rpm of both the pulleys. Driver pulley rpm is constant throughout the end.

Now pull the slider handle little towards you, this displaces the belt from initial position by means of roller. Now driven pulley's diameter has been reduced and driver pulley's

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diameter has been increased. Now measure driven pulley rpm. It has been increased from before reading. Similarly for every displacement of belt towards right i.e., towards small diameter of the driven pulley the rpm increases.

According to principle of belt and pulleys, when larger pulley rotates one revolution then smaller pulley rotates more revolution based on its diameter.

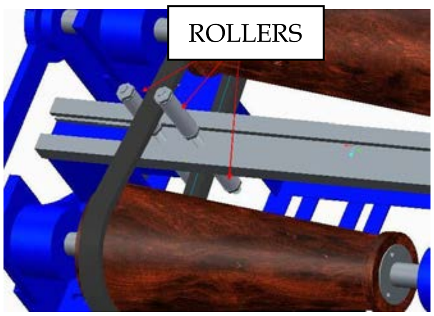


fig6 .Rollers assembly



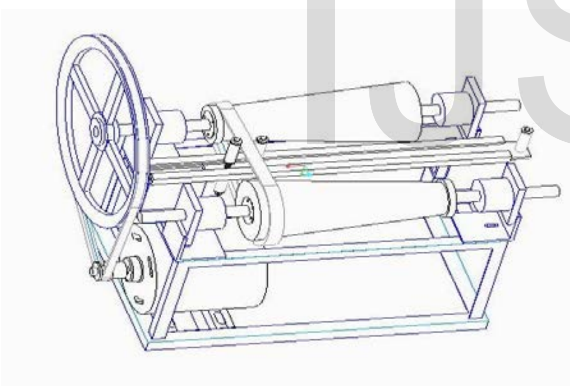

fig7 .Setup of Cone CVT

## 7 Pros

Better fuel consumption than a regular automatic transmission as the CVT is able to keep the car in its optimum power range regardless of speed. There is improved acceleration due to the lower power loss experienced. Step less transmission. i.e., no need of clutch It has the ability to allow the engine to rev almost immediately which delivers maximum torque. Provides a smoother ride than automatic transmission. Adapts to varying road conditions and power demands to allows for a better ride. Better emission control and less greenhouse gas emissions because of improved control of the engine's speed range. Easy to manufacture when compared to gear drives.

## 8 Application

Many small tractors for home and garden can have this rubber belt CVTs. Cone CVTs using belt drive can also be used in Go Kart vehicles which possess less load. It can also be used in small cars like TATA Nano, electric cars and hybrid vehicles.

Cone CVTs with gear cut and chain drive can be used in Formula one cars. It can be used in motor bikes using chain drive or belt drive. Cone CVTs can also be used in industrial machines for variable speeds. In lathe we use stepped pulley to control or change rpm of work piece, we have to stop machine and change belt for every specific work . When we use our manual cone cvt we can smoothly change the rpm without stopping the machine and changing the belt.
Cone cvt can be used in both vehicles and machines.

## 9 Conclusion

Thus the speeds $N_{1,}$ $N_2$ ,$N_3$ ,$N_4$ is determined with the help of the tachometer, these speed variations are noted. The tensions in the belt and type of the cone are the major aspects for the variation in speed. The torque is minimum at the start but when the belt returns maximum torque is obtained. Greater fuel efficiency than both manual and automatic transmissions can be obtained. Fuel savings of more than 17% have been achieved. Cheaper and lighter than Automatic transmissions. So it's smooth, responsive and quiet to drive. Our CVT's have a "manual" option, giving the driver more control, simulating a MT. This method is more mechanically efficient than Automatic transmissions and also decreases engine fatigue.

In Manual cone CVT's CPU can be configured to suit a wide range of driving modes and styles.The slipping in the drive belt or pulleys is no longer an issue due to new advances.
The internal combustion (IC) engine is nearing both perfection and obsolescence; advancements in fuel economy and emissions have effectively stalled. CVTs could potentially allow IC vehicles to meet the first wave of new fuel regulations.

As CVT development continues, costs will be reduced further and performance will continue to increase. This cycle of improvement will ultimately give CVTs a solid foundation in the world's automotive infrastructure.

## 10 Future work

### 10.1 Lathe Machine

In lathe we use stepped pulley to control or change rpm of work piece, we have to stop machine and change belt for every specific work . When we use our manual cone cvt we can smoothly change the rpm without stopping the machine and changing the belt.For this we should have gear cuts in our cone blocks for avoiding the slip and loss in torque and the rollers should be holding the belt in required position like in our prototype. As machining needs only specified rpm , the position of the belt should be marked in linear for getting required rpm in output shaft .Then the belt is moved to required position and it is locked to get required rpm.

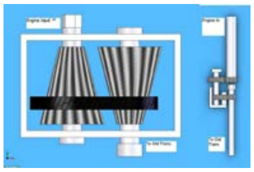

fig7 - Reversing Concept

This design aims to replace the current worm gear with a planetary gear system, which will allow for a high torque reverse drive. In forward drive mode the carrier ring will lock the center sun and outer ring gears together creating a rigid hub. In reverse mode the carrier ring will disengage from the center hub allowing the planet gears to reverse the directions of rotation of the outer ring. This concept will fit in the current housing and requires only a small hole drilled for the shift rod. The current center tine shaft threads will need to be replaced as shown to prevent the threads from “backing out” when reverse is engaged.



## 11 Acknowledgment

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## 12 References

[1] A Textbook of Machine Design by R.S. Khurmi, S.Chand Publication, 14th Edition.

[2] Continuously Variable Transmission by John Maten Bruce Anderson, Published by SAE International, 2006.

[3] Automotive Transmissions by Harald Naunheimer , Bernd Bertsche,Joachim Ryborz & Wolfgang Novak, Springer Publication , 2nd Edition.

[4] Bohen ., 2006 CVT Technologies.

[5] Brace et al.,1997; Brace et al.,1999; Mangialardi et al.,2002; Carbone et al.,2004.