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Trends in Continuously Variable Transmission System: A Literature Review

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ABSTRACT

Ample amount of research is going on since last two decades for improving the fuel economy and reduce power loses in vehicle by developing power train systems. Continuously variable transmission (CVT) is a solution for it. The CVT gives the continuously varying gear ratio instead of discrete ratios which saves fuel and gives better performance of vehicle that complies with the engine's working conditions and makes it optimal of the use. Vehicles with CVT gives better mileage and acceleration than the vehicles with traditional transmissions. CVT's capability and reliability was unknown to the automotive world until now as it was limited in the past. But as the development continues, cost will get reduced and performance will be increased. This paper helps in finding out the current systems in CVT and ongoing research and development.

Keywords***: Continuously variable transmission, Belt, Chain, eDrive etc.***

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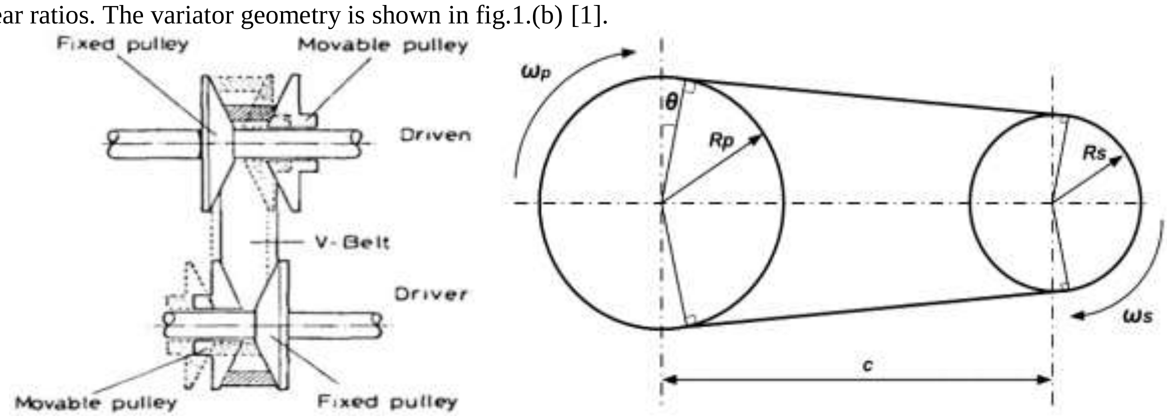
1. INTRODUCTION

Due to the growth in economy and environmental concerns in recent years the automotive fuel energy consumption has been an important aspects. Lot of research and development is going on in power transmission systems for increasing the fuel consumption and reducing emissions. For this the CVT is one of the solution, so it is important to understand the working and dynamic interactions of CVT which will help in making an efficient controller thereby reducing the emissions and increasing fuel economy. The Continuously Variable Transmission provides the promising platform foe enhancements in power train systems. As CVT provides infinite gear ratios between the two finite limits enables the engine to operate very close to the optimal efficiency line. CVT system gives advantages such as smoothness of operation, infinite gear ratios, easy drivability and power acceleration. There are many varieties of CVT each with its unique characteristics.

But first it's important to know basic working principle of CVT. CVT acts just like variator. It consists of two pulleys primary and secondary mounted on shafts and a V-belt connecting these two pulleys. Each driver an driven pulleys or primary and secondary pulleys consists of two pulleys fixed and movable pulleys each as shown in fig. 1.(a) [1]. The fixed pulley is fixed on the shaft and movable pulley can move in axial direction on the shaft. By changing the axial distance between the fixed and movable pulley we can obtain infinite gear ratios between its limit. If the movable pulley on the driver shaft is moved close to the fixed pulley the V-belt is forced to be pushed in outward radial direction, which increases the pitch belt diameter on driver shaft. as the centre distance between the two shafts and the length of belt is fixed the pitch belt diameter on driven shaft is decreased as it is forced to move inward in radial direction. This causes the reduction in gear ratios continuously. Thus we can get continuously varying gear ratios. The variator geometry is shown in fig.1.(b) [1].



(a) **(b)**

Fig. 1.(a) Principle of a V-belt CVT; (b) Variator geometry[1]

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2. VARIOUS TYPES OF CVT

There are many types of CVTs each with its own unique characteristics, but belt and chain CVTs have gained more importance as they were able to meet the requirements at some context. Following are some types of CVTs.

2.1. Push Belt CVT

Push Belt type of CVT is the most common type. It has a belt composed of segmented steel blocks stacked on a steel ribbon as shown in Fig.3[2]. This belt is used to transmit power between two conical pulleys or sheaves, one fixed and one moving. With this special type of belt it also uses a electronic circuit for continuously changing the distance between the pulleys depending on the engine output which is analogous to the shifting of gears [2]. The advancement in push belt type has been rapid in few years and it has drawn more attention of automakers.

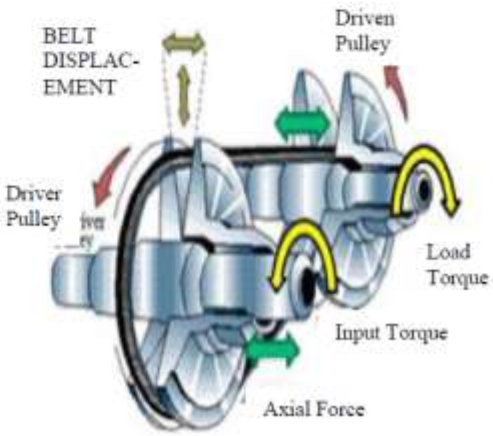

Fig. 2.Model of Push Belt CVT [8]

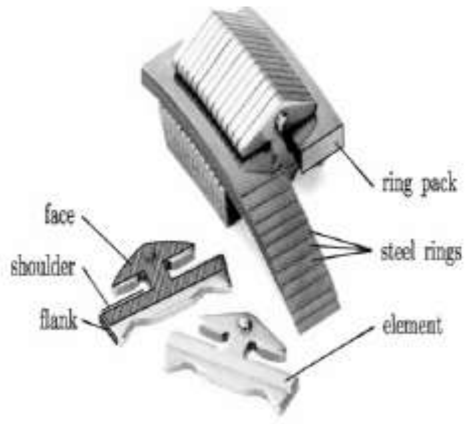

Fig. 3.Composition of Push Belt[8]

2.2. Toroidal Traction-Drive CVT

This type of CVT uses the high shear strength of the viscous fluid for transmitting the torque between two torus, input and output. Each torus is made of two torus fixed and movable. The movable torus slides linearly and changes the angle of roller relatively on each shaft, as shown in Fig.4 [2]. This gives continuously varying gear ratios.

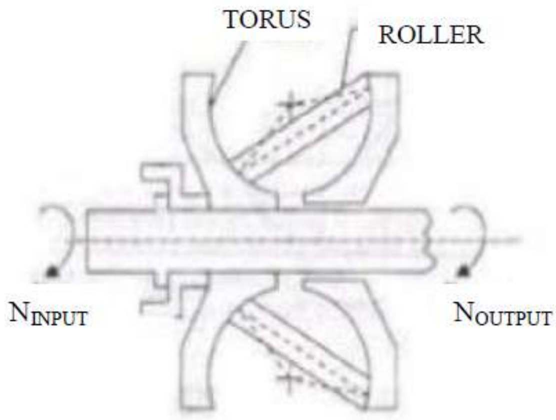

Fig. 4.Toroidal CVT[2]

2.3. Variable Diameter Elastomer Belt CVT

This type uses the flat flexible belt mounted on movable supports, as shown in Fig.5 [2]. These supports can radius continuously thus changing the gear ratios. But this type of CVT has CVT has disadvantages like creep and slip due to supports separating at high gear ratios and forming a discontinuous path. So this has led development in direction of Push Belt CVTs.

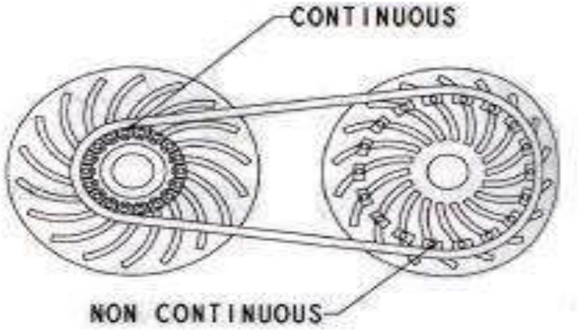

Fig. 5. Variable Diameter Belt CVT[2]

2.4. Nutating Traction Drive CVT

This type of drive uses a pivoting, conical shaft to change the gear ratios which is analogous to hanging gears in CVT. As the cone angle changes the inlet radius decreases and outlet radius increases, resulting in change in gear ratio. Thus by changing cone angle between two limits an infinite gear ratio can be obtained.

3. SINGLE ACTING PULLEY ACTUATOR CVT

This is the modification in the Push Belt type of CVT here the servomotor is utilized as an actuator and a spring mechanism is also utilized. The primary pulley's movable sheave is actuated by the servomotor with gear reducer and power cam mechanism and movable sheave of secondary pulley is actuated by the spring mechanism for the clamping force, as shown in Fig.6 [1]. A spring disc is inserted in the back of the secondary pulley sheave to provide a continuous clamping force to the belt to reduce the slip during transmission. When CVT is transmitting, the change in gear ratio is required the servomotor will actuate the primary pulley in axial direction to the required value, at the same time the spring mechanism will actuate the secondary pulley to adjust the radius to required value and provide a optimal clamping force to prevent slippage. Thus the modification in CVT reduces the slip and makes it more efficient for use [1].

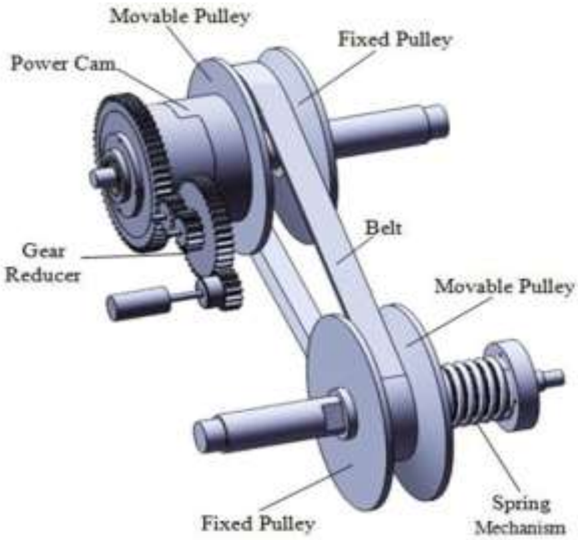

Fig. 6. Single Acting Pulley Actuator CVT[1]

4.CVT FOR EFFICIENT URBAN TRANSPORTATION

Adaptation of CVT technology to lighterweight drives that would be appropriate for use in bicycles. The design, research, and development of eDrive sprung out of the understanding of the limitations of existing bicycle transmissions. This uses a computer and shifter mechanism to change the diameter of the variable diameter sprocket. eDrive promises to provide the efficiency, ease of use, and extended functionality to significantly augment the use of bicycles, enabling them to play a more significant role in sustainable urban transportation [3].

The primary components of the eDrive are a computer, shifter, and drive assembly, as shown in Fig.7. The computer can be anything which can either be installed on bicycle or the it can be tablet or smartphone or anything that can worn by the rider. The shifter mechanism can be coupled with the handlebar grip or brake handle and also computer and shifter can be combined into a single device. The drive assembly consists of the spring loaded camming device and two spaced apart discs. Pulleys segments are used which are placed between the two discs and a belt is used to transmit torque. Belt is mounted on pulley segments which transmits the torque, the camming device is used to provide sufficient sliding resistance which would result in torque transfer between the belt and pulley segments. The two discs have different slots in each, one has straight slots and another curved, mainly to obtain the varied effective diameter and proper pulley segments positioning. Fig. 8 shows the eDrive drive assembly which is taken from reference [3].

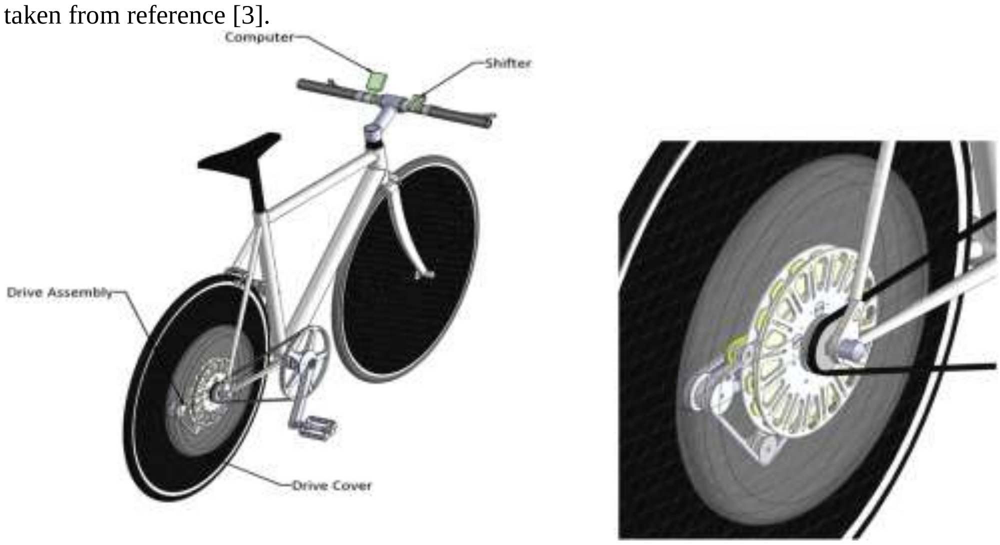

Fig. 7. eDrive assembly on bicycle in operation with a close-up of the assembly (right).[3]

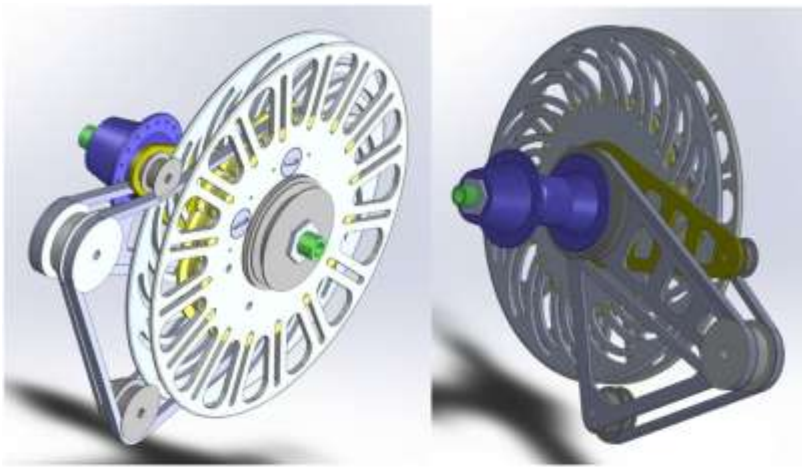

Fig. 8. eDrive drive assembly.[3]

5.CONCLUSION

Many more research has been going on in the field of CVT. Various development and modifications are going on to make CVT more efficient. As CVT is an ideal transmission system for vehicles which can on the one hand make bigger opportunity for automakers to improve their potential customers as well as improving the efficiency of their automobiles, firstly by equipping their current products with CVT instead of MT, and secondly by designing new products equipped with high efficient CVT; and on the other hand, CVT is a more environmentally friendly transmission system compared with the other kinds of transmission systems and it can help reduce air pollution. Furthermore, this paper reveals that this system can ameliorate even more by improving its mechanism and probably designing a new generation of it in the future.

So to conclude, if we implement CVT in proper way of functioning we can improve and change the whole world of automobile.

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