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OVERVIEW OF POWER TRANSMISSION SYSTEM AND NEW TRENDS IN CVT SYSTEM FOR AUTOMOBILE

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Abstract: Continuously variable transmission or CVT continues to derive a important technologies for improving fuel efficiency of automobile. CVTs uses drive ratios instead of discrete ratio to obtain optimal performance of engine. Vehicle with CVT attain better mileage and acceleration than traditional transmission. CVTs are not unknown to the automotive world but their capability and reliability have been limited in past. As CVT development continues, cost will reduced and performance will increase. This paper helps in finding out the current state of CVTs and upcoming research and developments.

Keywords: Optimization, coil handling, load weighing.

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INTRODUCTION

As we know that the transmission is the device that connects to the engine and transfers the power of engine to the wheels of vehicles. The power transfer to wheel may be front runs at or rear or both depending on the power transmission system. An delivered the power from engine to wheel. This process of power transmission from engine to wheel done through the various gear combination. In the first gear engine turn much faster than drive wheel while in high gear the car may going excess of 70 MPH. In addition to suitable number of forward gears, power transmission system also consist of neutral gear which disconnects the engine from the drive wheel. Type of transmission becomes one of the main aspects chosen by the buyer in buying a car other than the size of car, type of engine, and also the manufacturer of car. Nowadays, there are about three popular most popular types of transmission being used in the whole world wide. Those transmissions are manual transmission, automatic transmission, and also continuously variable transmission (CVT). But automatic transmission and CVT provides better handling compared to manual transmission where the driver don't need to shift the clutch manually using a gear knob. Therefore, a lot of buyer nowadays chose a car with automatic transmission and CVT compared to the car with manual transmission. Both conventional automatic and CVT has their own advantages and disadvantages. One of the advantages of CVT is that it can work to keep engine at optimum power range and simply raises and lowers the engine speed as needed. The following fig. shoes the power transmission system in four wheeler in which power being transfer from engine to wheels.

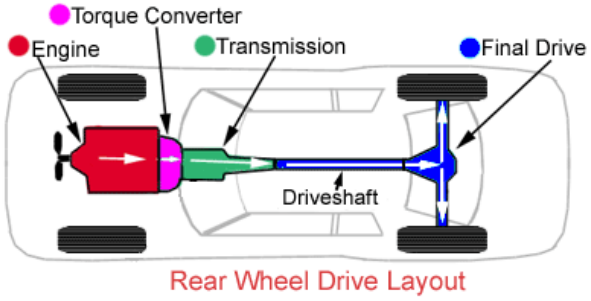
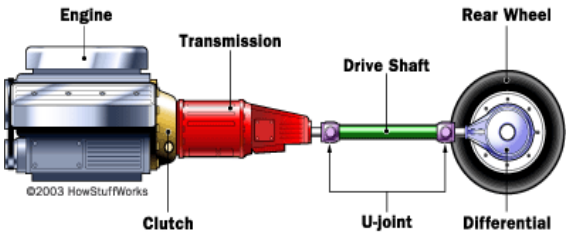


Fig. General power transmission system

The transmission is usually mounted back to the engine. The drive shaft connect the rear of the transmission to the final drive which is located in the gear axel and used to send power to the rear wheels. This power system is quite simple and straight forward in direction, going from the engine through torque converter, it reach gear box transmission and then drive shaft coupled with gear box until it reaches to final drive where it is split and send to the two gear wheel.

II.TYPES OF POWER TRANSMISSION SYSTEM

The most common transmission system that have been used for the automotive industry are manual transmission, automatic transmission, semi-automatic transmission and continuously variable transmission



1)Manual transmission: Manual transmission was the first invented transmission system. the driver needs to disengage the clutch to disconnect the power from the engine, first select the target gear and engage the clutch again to perform the gear change again. It always need some time to acquire the skills for new driver.

2) Automatic transmission:

It consist of fluid coupling torque converter instead of clutch to avoid the engagement of clutch during gear shifting. a completed set of gear is called as planetary gear which is used to perform gear ratio change instead of selecting gear manually. due to the automatic transmission driver does not need to worry about gear selection during driving. it makes driving of car much easier especially for disable or new driver. the main h of system is that, due gear contact of the torque converter the power loss occurs during transmission of power and the complicated planter structure makes the transmission heavy and easily broken.

3)Semi-automatic transmission:

As name indicates it is the combination of manual and semi-automatic transmission system which utilizes advantages of both automatic and semi-automatic transmission system but their disadvantages. Due to its complicated design which is still under development and its high price it is only used for some luxury and sports cars.

4) CVT System:

It has been used for low powered machinery like scooters for a long time due to its highly efficient gear change. because of the strength of driving belt it was challenging to install it on

high power machinery but with the progress of the material technology, engineerss have been successfully installed it on the automobiles making the power transmission efficient.

III.CONTINUOUS VARIABLE TRANSMISSION

A continuously variable transmission, or CVT, is a type of automatic transmission that provides more useful power, better fuel economy and a smoother driving experience than a traditional automatic transmission. Traditional automatic transmissions use a set of gears that provides a given number of ratios (or speed). The transmission shifts gears to provide the most appropriate ratio for a given situation: Lowest gears for starting out, middle gears for acceleration and passing, and higher gears for fuel-efficient cruising. The CVT replaces the gears with two variable-diameter pulleys, each shaped like a pair of opposing cones, with a metal belt or chain running between them. One pulley is connected to the engine (input shaft), the other to the drive wheels (output shaft). The halves of each pulley are moveable; as the pulley halves come closer together the belt is forced to ride higher on the pulley, effectively making the pulley's diameter larger. Changing the diameter of the pulleys varies the transmission's ratio (the number of times the output shaft spins for each revolution of the engine), in the same way that a 10-speed bike routes the chain over larger or smaller gears to change the ratio. Making the input pulley smaller and the output pulley larger gives a low ratio (a large number of engine revolutions producing a small number of output revolutions) for better low-speed acceleration. As the car accelerates, the pulleys vary their diameter to lower the engine speed as car speed rises. This is the same thing a conventional transmission does, but instead of changing the ratio in stages by shifting gears, the CVT continuously varies the ratio -- hence its name.

IV.TYPES OF CVT

The continuously variable transmission replaces discrete gear ratios with infinitely adjustable gearing through one of several basic CVT designs. The different types of continuously variable transmission are as follows.

1] PUSH BELT

This most common type of CVT uses segmented steel blocks stacked on a steel ribbon, as shown in Figure (1). This belt transmits power between two conical pulleys, or sheaves, one fixed and one movable . With a belt drive: In essence, a sensor reads the engine output and then electronically increases or decreases the distance between pulleys, and thus the tension of the drive belt. The continuously changing distance between the pulleys—their ratio to one

another—is analogous to shifting gears. Push-belt CVTs were first developed decades ago, but new advances in belt design have recently drawn the attention of automakers worldwide.

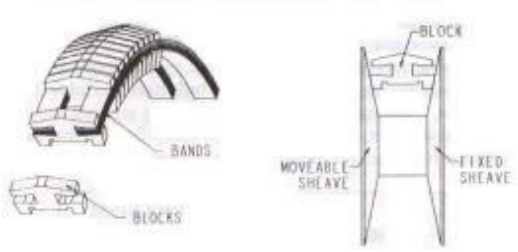


Figure (1) – Metal Push Belt CVT

2]Toroidal Traction-Drive

These transmissions use the high shear strength of viscous fluids to transmit torque between an input torus and an output torus. As the movable torus slides linearly, the angle of a roller changes relative to shaft position, as seen in Figure (2). This results in a change in gear ratio.

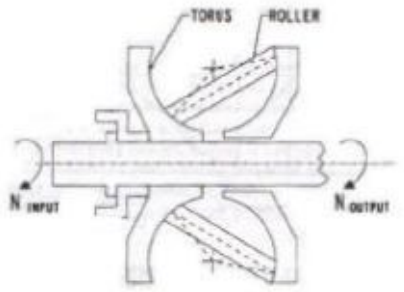


Figure (2) – Toroidal CVT

3] Variable Diameter Elastomer Belt

This type of CVT, as represented in Figure (2), uses a flat, flexible belt mounted on movable supports. These supports can change radius and thus gear ratio. However, the supports separate at high gear ratios to form a discontinuous gear path, as seen in Figure (3). This can lead to the problems with creep and slip that have plagued CVTs for years [3]. This inherent flaw has directed research and development toward push belt CVTs.

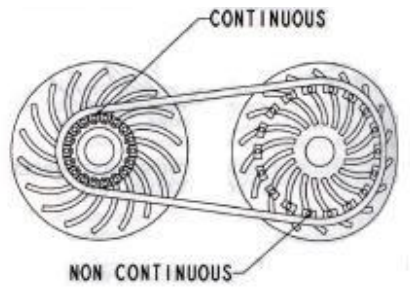


Figure (3) – Variable Diameter Belt CVT

V. Other CVT Varieties

Several other types of CVTs have been developed over the course of automotive history, but these have become less prominent than push belt and toroidal CVTs. A nutating traction drive uses a pivoting, conical shaft to change "gears" in a CVT. As the cones change angle, the inlet radius decreases while the outlet radius increases, or vice versa, resulting in an infinitely variable gear ratio . A variable geometry CVT uses adjustable planetary gearsets to change gear ratios, but this is more akin to a flexible traditional transmission than a conventional CVT.

VI. Advantages & Benefits

Certainly, the clunking sound of a shifting transmission is familiar to all drivers. By contrast, a continuously variable transmission is perfectly smooth—it naturally changes "gears" discreetly and minutely such that the driver or passenger feels only steady acceleration. A CVT would cause less engine fatigue and would be a more reliable transmission, as the harshness of shifts and discrete gears force the engine to run at a less-than-optimal speed. Engines do not develop constant power at all speeds; they have specific speeds where torque. horsepower o fuel efficiency are at their highest levels. Because there are no gears to tie a given road speed directly to a given engine speed, the CVT can vary the engine speed as needed to access maximum power as well as maximum fuel efficiency. This allows the CVT to provide quicker acceleration than a conventional automatic or manual transmission while delivering superior fuel economy. Table I shows the power efficiency of a typical five speeds automatic, which is the percentage of engine power transmitted through the transmission. This yields an average efficiency of 86%, compared with typical manual transmission with 97% efficiency . By comparison, Table II shows the efficiency range for several CVT designs.

Table 1: Efficiency various gear ratio for automatic transmission.

Gear	Efficiency Range
1	60~85%
2	60~90%
3	85~95%
4	90~95%
5	85~94%

Table 2: Efficiency of various CVT designs

CVT Mechanism	Efficiency Range
Rubber belts	90~95%
Steel belts	90~97%
Toroidal traction	70~94%
Nutating traction	75~96%
Variable geometry	85~93%

These CVTs offer improved efficiency over conventional transmission, and their efficiency depends less on driving habit than manual transmission. Since CVT allows an engine to run at its most efficient point virtually not dependent of the vehicle speed, a CVT equipped vehicle yields fuel economy benefits when compared with a conventional transmission. Testing by ZF Getrie be GmbH for U.S. Environmental Protection Agency City and Highway Cycles several years ago found that the CVT uses at least 10% less fuel than a 4 speed automatic transmission. The CVT was more than one second faster in 0~100Km/h acceleration tests than that of manual transmission.

VII.DISADVANTAGES OF THE CVT

The CVT's biggest problem has been user acceptance. Because the CVT allows the engine to rev at any speed, the noises coming from under the hood sound odd to ears accustomed to conventional manual and automatic transmissions. The gradual changes in engine note sound

like a sliding transmission or a slipping clutch -- signs of trouble with a conventional transmission, but perfectly normal for a CVT. Flooring an automatic car brings a lurch and a sudden burst of power, whereas CVTs provide a smooth, rapid increase to maximum power. To some drivers this makes the car feel slower, when in fact a CVT will generally out-accelerate an automatic.

VIII. Challenges & Limitations

The progress in CVT development has been slowly due to different kinds of reasons, with much of the delay in its development can be attributed to the lack of demand, while the conventional manual and automatic transmission have long offered sufficient performance and fuel economy. In addition, this problem is also possibly influenced by unsuccessful efforts to develop a CVT that can match the torque capacity, efficiency, size, weight, and manufacturing cost of step-ratio transmission. One of the major complaint with previous CVTs is the slip in drive belt or rollers. This is caused by the lack of gear teeth, which form a rigid mechanical connection between two gears; friction drivers are inherently prone to slip, especially at high torque. For many years, the simple solution to this problem has been by limiting the usage of CVTs only in cars with relatively low torque engine . Another solution is by employing a torque converter, but this reduces the CVT's efficiency. With the improvements in manufacturing technique, technology material processing ,metallurgy , advance electronic control and advance engineering , CVTs can be applied in cars with high torque engine. Manual transmissions have manual controls, where the desired gear ratio totally depends on the driver to shift it and automatic transmissions have relatively simple shifting algorithms between three to five gears. However, CVTs require a more complex algorithm to accommodate an infinite division of speed and transmission ratios.

IX. FEW CVT RESEARCH

As recently 1997,CVT research has been focused on the basic issues of drive belt designing and power transmission. Now , as belts developed and produced by Van Doome's Transmissie (VDT) and other companies are better and reliable , the CVT becomes sufficiently efficient. The system developed by Nissan to obtain the demand drive torque with optimum fuel

Economy. The control system determines the desired CVT ratio based on a target torque, vehicle speed, and desired fuel economy. Honda has also developed an integrated control algorithm for its CVTs, regarding not only the engine's thermal efficiency but also work loss from drive accessories and the transmission system itself. Testing of Honda's algorithm with a prototype vehicle resulted in one percent fuel economy increase compared with a conventional

algorithm. Although it is not a significant increase but it will becomes one of the basic and important technologies for the next generation.

X. FUTURE ASPECTS

It is observed that much of the existing literature is quick to admit that the automotive industry lacks a broad knowledge base regarding CVTs. Whereas conventional transmissions have been continuously refined and improved since the start of the 20th century, CVT development is only just beginning. As infrastructure is built up along with basic knowledge, CVTs will become best and more prominent in the automotive area. Even today's CVTs, which represent first-generation designs at best, outperform conventional transmissions. Automakers who fail to develop CVTs now, while the field is still in its infancy, risk being left behind as CVT development and implementation continues its exponential growth.

HYBRID ELECTRICAL VEHICLE AND CVT

CVT will help to prolong the ability of internal combustion engine. Few companies are currently studying implementation of CVTs with HEVs. Nissan recently developed an hybrid electrical vehicle with best fuel efficiency more than double of that of existing vehicles. Korean automaker Kia has proposed new approach regarding to CVT s and their application to HEV. He recently tested a system in which the CVT allows to run at constant speed and motor allows the engine to run at constant torque which does not depend upon driving condition thus both gasoline engine and electric motor always runs at their optimal speed. Kia also presented a control system for this HEV-CVT combine action increase fuel efficiency for next generation.

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