Continuously Variable Transmission (CVT)

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***Abstract*: The five essential principles that can be used be applied when the transmission is continuously variable (CVT) are examined and compared in this research, as well as how CVTs are more dominating than a Geared transmission system. Typically, the term "continuously variable transmission" denotes that torque can be changed independently of the speed ratio and vice versa. To put itanother way, the torque converter in a normal car is not a CVT because the speed ratio is determined by the torque transmitted. Traditional automatic and manual gearboxes, on the other hand, have multiple fixed transmission ratios that force the engine to runoutside of its optimal operating range. The requirement for a transmission system, as well as the functioning principle andconstructional characteristics of CVTs, have all been thoroughly studied. A continuously variable transmission (CVT) is one that can change gears at any time between maximum and minimum gear ratios in an endless number of ways while driving. Other Mechanical transmissions, on the other hand, have a limited number of gear ratio options. For a variety of vehicle speeds, allowing the engine to run at its most efficient revolutions per minute (RPM). reduces fuel consumption. This transmission can give higher fuel economy than traditional transmissions.**

Keywords:- CVT, Types of CVT, Transmission Compression,Working of CVT, CVT assembly.

1. INTRODUCTION

What exactly is a CVT? Over time, a continuously variable transmission (CVT) can change to any effective gear ratio between a predefined upper and lower limit. Most production cartransmissions, on the other hand, only have 4–6 particular gear ratios to choose from. A CVT's nearly limitless variability allowsthe engine to keep a steady speed as the vehicle accelerates. If the CVT is arranged so that the engine produces the most power and/or runs the most efficiently, this could lead to improved vehicle performance Between effective gear ratios, there are no steps. because effective gear ratios do not have any. CVTs function without the jerks that occur when a traditional transmission is switched to a different gear. Ironically, this apparent advantage is one of the main reasons why they aren't employed more in production vehicles today. Drivers are confused when the automobile accelerates smoothly without driving normally higher When they push the accelerator pedal, they expecting the car to jerk or the engines noise to change. harder. Unfortunately, drivers interpret this as a lack of power inthe automobile, which is causing a marketing dilemma for the transmissions.

Although the Continuously Variable Transmission (CVT) has been around for over a century, it was only recently introduced into automobile applications. The great majority of cars on the road haveeither a manual or a basic automatic transmission. These gearboxes use meshing gears to create discrete ratio steps between the engine and vehicle speed. However, there are other methods that may transmit power while also providing continuous variable transmission. Continuous variable transmission is a type of transmission that allows for a step- less ratio adjustment. A CVT (Continuously Variable Transmission) is a form of automatic transmission that offers a wide range of gear ratios. Rather than a few discrete ratios like a standard transmission. It was only employed in industrial applications until recently, such as running lathes and light-duty drill presses. With the development of upgraded materials such as high-density belts, improvedhydraulics, and, more recently, high-speed sensors and microprocessors, the scene was set for CVT's entrance in the automotive sector.

Fig 1: CVT

2. ABOUT CVT/OVER VIEW OF CVT

- CVTs and how they boost performance, for example. The objective of CVTs is to continuously vary the transmission ratio.
- CVT optimizes efficiency by allowing the engine to run at itsbest RPM regardless of the vehicle's speed.
- Continually changes the transmission ratio.
- Shifts in an unlimited number of ratios automatically.
- Power is delivered in a smooth and consistent manner.
- Adapts its gear ratio on a regular basis to improve engineefficiency.
- There will be fewer greenhouse gas emissions.
- Fuel usage is reduced, and greenhouse gas emissions arereduced.

3. OBJECTIVES

- To comprehend CVT's basis of operation.
- To understand the differences between a CVT and a GearTransmission system,
- To become familiar with CVT components.

4. WORKING OF CVT

A Continuously Variable Transmission is used to alter the functioning diameter of the transmission's two main pulleys (CVT). The connecting belt is held in place on the pulleys by V- shaped grooves. The pulley has one fixed side and one moving side, which is controlled by a hydraulic actuator. The hydraulic actuator has the ability to change the distance between the two sides of the pulley.

Depending on driving circumstances, this adjusts the gear ratio bycausing the belt to ride lower or higher along the inside walls of the pulley. This action has no "steps" because it is eternally changeable. As a result, a CVT can keep the engine running at itsoptimal rpm. increasing economy and gas mileage.

As previously stated, oil pressure in the hydraulic actuator adjuststhe two pulley widths in response to throttle position, speed, and other parameters sensed by microprocessors and other sensors.

Fig 2: Working of CVT

LOW GEAR

- CONDITION: LOW RPM, HIGH TORQUE.
- Ability to quickly accelerate from a full halt.
- Capable of climb hills, high inclined areas.
- Top speed is limited

TOP GEAR

- CONDITION: HIGH RPM, LOW GEAR
- Slow acceleration when starting from complete stop.
- Wouldn't or difficult to climb hills.
- Top speed is relatively high.

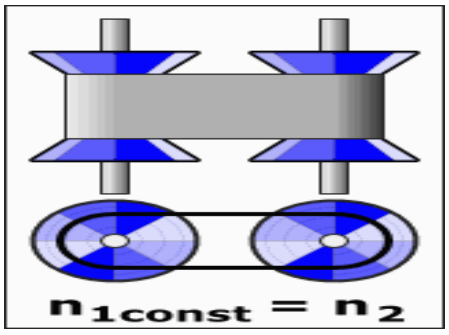

Fig 3: Pully diameter changing.

5. THE VARIOUS TYPES OF CVT

A. CVTs WITH FRICTIONAL TYPES/PULLEY BASED.

The most common type of CVT is the frictional CVT, in which two bodies are brought into contact at different distances from their axis of rotation, and motion is transferred from one body to the other viafriction. A third body, usually a wheel or a belt, serves as an intermediate. is occasionally present. The "disc and wheel" conceptappears to be the most basic CVT, in which a wheel sits on thesurface of a revolving disc and can be dragged along its splined axleto contact the disc at various distances from its centre. The speedratio of such a device is the radius of the wheel divided by the distance from the contact point to the disc's centre. In frictional CVTdesigns, friction plays a major role; the maximum torquetransmissible by such a device is [Tmax = Cf FN Ro] The torqueoutput is to, the wheel-to-disc coefficient of friction is Cf, the forcedriving the wheel into the disc is FN, and the radius of the outputwheel or disc is Ro. Depending on the materials used, the coefficientof friction varies. Rubber on steel has a higher coefficient of friction than steel on rubber.

Fig 4: Low Gear

Fig 5: High Gear

B. TOROIDAL OR ROLLER BASED CVT

The simplest toroidal CVT is made up of two coaxial discs with annular groves on their facing surfaces with a semi-circular cross section. The discs are spaced so that the cross sections' centers are aligned. Two or more idler wheels, with axes perpendicular to andintersecting the disc axes, are positioned between the discs, with a radius equal to the cross-sectional radius of the grooves

Fig 6: Toroidal CVT Model

Although the components of such a system appear to be dramatically different, they are all equivalent the same results as a belt-and- pulley system - a continuously variable transmission The followingis a description of how it works.

- The engine is connected to one disc. This is the same as adriving pulley.
- The drive shaft is connected to another disc. This is thesame as a driven pulley.
- Between the discs, rollers, or wheels, operate as a belt,distributing power from one to the other.

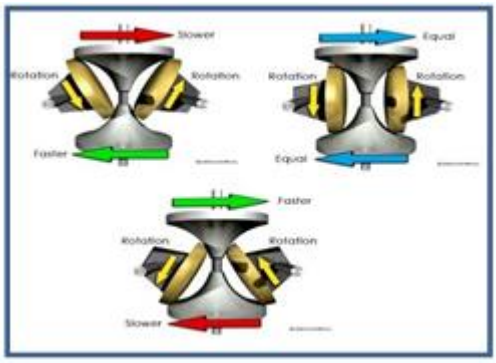

Fig 7: Toroidal CVT roller

C. HYDROSTATIC CVT

Hydrostatic CVTs convert rotational motion into fluid flow (hydrostatic pump) before returning to rotational motion (hydrostatic motor) In various situations, a variable displacement pump is used to continuously change the fluid flow. In some circumstances,The hydrostatic motor, is the variable displacementunit.

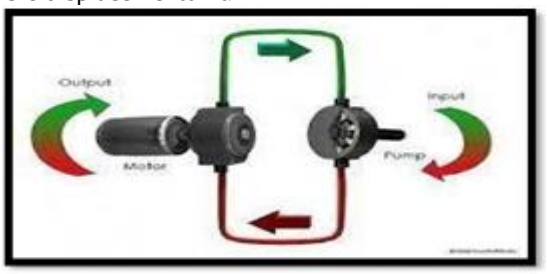

Fig 8: Hydrostatic CVT

6. CVT ASSEMBLY

The whole CVT assembly is seen in the diagram below. It includescomponents like as pulleys, belts, bearings, shafts, gears, screws, rings, and more. The majority of the components are made of steel. The assembly is made in accordance with industry norms.

a. PLANETARY EQUIPMENT

Planetary gear consists of a sun gear encircled by many planetarygears encompassed by a ring gear, as the name implies. Theplanetary gearset of a CVT is used to create forward and reverse motion via clutch motion/alignment. Steel will be used, and it willprovide strength to the gears in both forward and backward directions.

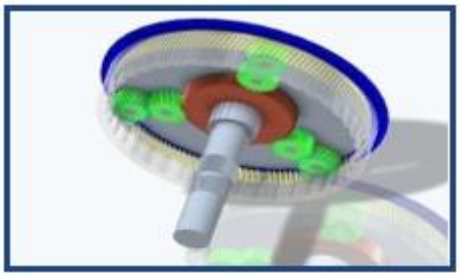

Fig 9: Planetary gearset

b. BEARINGS

Bearings, a key component of any moving machinery, play a complementary function in ensuring smooth operation and effective performance. Therefore, our CVT also makes advantageof it. The bearing utilized is a steel ball bearing that is sealed on both ends.

Fig 10: Ball Bearings

c. BELT

The belt is the most crucial component in this gearbox, as its operation limits the transmission's overall functionality. It is made up of steel rings that are piled on top of each other, as seen in the diagrams below:

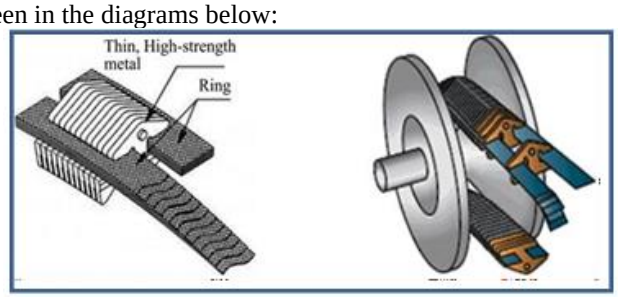

Fig 11: Steel and Rubber Belt

d. PRIMARY PULLY

Through gear meshing, the primary pulley is connected to the enginevia a shaft. The right pulley is attached to the drum in the diagram below, which is responsible for expansion and contraction to modify gear ratios. It's made of gleaming steel with a high-gloss finish.

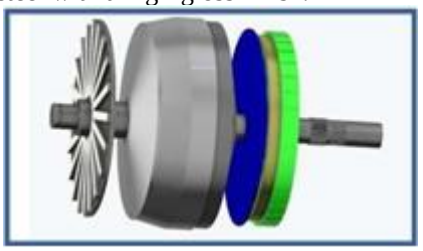

Fig 12: Primary Pully

e. SECONDARY PULLY

Through gear meshing, the secondary pulley is connected to the output via a shaft. The right pulley is attached to the drum in the image below, which is responsible for expansion and contraction forgear ratio modification. It also contains a firm spring as depicted. It's composed of gleaming steel with a very high surface finish to reduce wear.

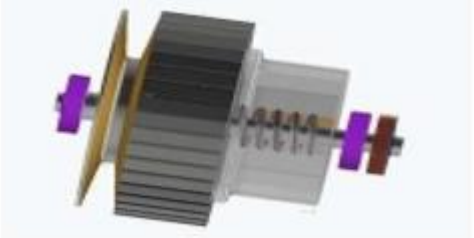

Fig 13: Secondary Pully

7. PROBLEMS WITH MANUAL AND AUTOMATIC TRANSMISSION

- Transmission hesitation.
- Gears slipping.
- Transmission fluid leakage.
- Making noise.
- Overheating transmission.
- Unresponsive transmission.
- Because traffic has become unbearable in our major cities, gasoline consumption has increased.
- conventional automatic transmissions always take slightly more fuel than manual transmissions, and sophisticated automatics are scarce.

GRAPH: MANUAL V/S AUTOMATIC V/S CVTTRANSMISSION

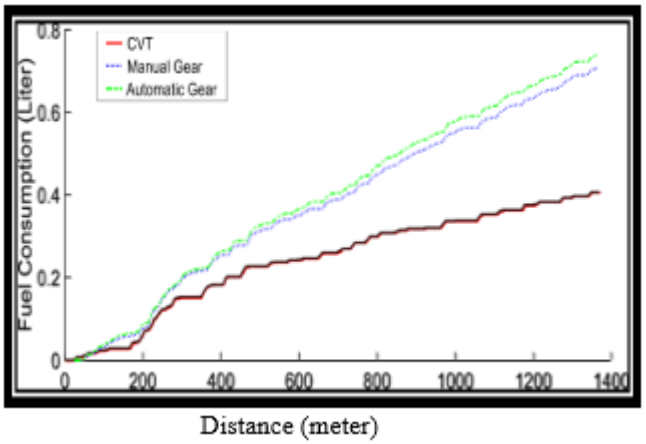

Fig 14: Overall fuel consumption for UDDS driving cycle.

8. ADVANTAGES

- There will be no shift clunk, and stronger pollution controlswill result in fewer greenhouse gas emissions.
- CVTs offer an endless number of gear ratios as well asincreased performance.
- The transmission ratio can be changed at any time.
- Inside the CVT, pulleys and a belt smoothly change gear ratioswith no "shift shock" or delay.
- Infinite ratios provide for a continuous cruising speed whilereducing pollution and improving fuel economy.
- Help make sure that the engine torque is at its peak (loadedvehicles).
- By continuously adjusting the ratios, a CVT aids in keepingthe engine in its optimum rpm range.
- boosting fuel efficiency and reducing engine strain.
- CVTs accelerate faster and more smoothly than traditional automatic transmissions.
- Since there are fewer parts in a CVT, it is less expensive to manufacture than a standard multispeed automatic.
- CVT removes manual transmission gear shifts and the resulting increase and fall in engine speed.
- CVT also reduces gearhunting, which is especially important when driving up a hill or in high-inclined terrain.

9. DISADVANTAGES

- Steel metal belts are utilized in CVTs, which have a lower torquetransferring capacity and so cannot be employed in big cars. Its use is restricted to tiny vehicles.
- Greater wear and sliding are caused by friction between the belt and the pulley.
- The transmission fluid is somewhat pricey.
- Reverse gearing necessitates an additional gear train, which is larger and more expensive than manual transmissions.

10. APPLICATION

- Tractors, require a flexible system to transfer power from the engine to the wheels. The CVT will do just that, whilealso saving a lot of money on fuel and reducing pollutants inthe atmosphere.
- The CVT will benefit golf carts in the same way as it willbenefit electric cars Benefits include a wide range of speeds, a longer driving range between charges, fewer batteries, lower maintenance costs, and reduced weight..
- Ride-on lawnmowers, which look like little tractors, run ongas and pollute the environment. The CVT method can help you avoid problems. on ride-on vehicles fromcontaminating the air as much as they do presently.
- Motorized Wheelchairs: Run on batteries and include a rheostat to control the speed. Slowly ascending a ramp resultin a loss of power (at a time when it's most needed). CVT is a type of transmission in which the lower the speed, the more power.
- When riding a bicycle, have you ever tried shifting When cycling uphill, do you use gears? The good news is that the CVT will automatically figure out which optionis best for you. gear ratio for the situation. There's no muss, no fuss. The story comes to a close.
- Power tools: For smoother performance and greater reliability, household appliances ranging from tabletop drillsto washers and blenders must abandon the centuries-old belt and pulley configuration.
- Industrial Equipment: Gears or heavy belt and pulley combinations are frequently used in production machinery.
  CVT can eliminate all of that, as well as provide them withunlimited ratios.
- Mini Machines: Small equipment that must function at a variety of speeds depending on the situation. Our one-of-a- kind design allows them to make a low-cost small CVT. to help them achieve just that.

11. FUTURE OF CVT

- Truly continuously variable.
- Transmit torque for both forward and backward wheels.
- Abel to transmit high torque levels.

- computer control not required.
- Mechanical losses are less.

12. CONCLUSION

A continuously variable transmission (CVT) is one that can vary its gear ratio at any time. gears at any time. between maximum and minimum gear ratios in an endless number of ways while Riding. Other mechanical transmissions, on the other hand, only a few distinctgear ratios are available. Because of the CVT's flexibility, the driving shaft can maintain a constant angular velocity throughout a wide range of output speeds. This transmission can provide better fuel efficiency than regular transmissions by letting the engine to run at its most economical revolutions per minute (RPM) for a variety of vehicle speeds.

- Rubber belt / variable pulley CVTs are found in almost all snowmobile and motor scooter CVTs.
- With increased fuel efficiency, unlimited gear ratios, reduced production costs, steadier cruising speeds, and better acceleration capabilities, CVT is undoubtedly a technology of the future.
- Because CVT is the most advanced power transmission technology, most of us must become accustomed to the characteristics of a CVT-equipped car in order to appreciate it fully.
- It would be a generally accepted technology all across the world.

REFERENCE

[1] Mandy Concepcion “Automotive Continuously Variable Transmissions – CVT” Kindle -2 Editions. Published On 15 May2013.
[2] Ms. Tanvi Dilip Challirwar .BE, Mechanical Engineering. Gokhale Education society’s college of Engineering. International Journal of Engineering Trends and Technology (IJETT) - Volume67 Issue 3 - March 2021.
[3] C.de Silva, M. Schultz (2002) “Kinematic analysis & Design of aCVT” Volume-67 Issue-3 by IJETT Journal (IJETT). JAN 2019.