HALF TOROID CVT SYSTEM

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Abstract: A continuously variable transmission (CVT) is a usual transmission that can change seamlessly through a continuous range of effective gear ratios and CVT also known as a single-speed transmission, stepless transmission, pulley transmission, or, in case of motorcycles, a twist-and-go. This contrasts with other mechanical transmissions that offer a set number of gear ratios. The suppleness of a CVT allows the input shaft to maintain a constant angular velocity. A continuously variable transmission (CVT) transfers power throughout a range of speed/torque ratios from engine input towards output, continuously exclusive of interruption. Contrast with either manual or conventional automatic transmissions that make use of discrete ratios as well as normally disengage when changing ratio. The CVT grouping includes infinitely variable transmissions (IVT) so that give a zero output speed within the operating range. The "Half Toroidal" type CVT scheme has basic component arrays. This work documents a successfully developed experiment of a "Half Toroidal" continuously variable transmission (CVT) by adjusting its geometrical arrangement of CVT design as well as compared the experimental results of torque, speed, and power delivered at the output disc with those obtained by a theoretical.

Keywords: "Toroidal drive‟, infinite speed ratios by toroidal drive, CVT (continuously variable transmission)

I. INTRODUCTION

A continuously variable transmission (CVT), conversely, is a type of transmission that allows an infinitely variable ratio change in a finite range, thereby allowing the engine to continuously operate in its most efficient or highest performance range. The Half Toroidal is one of the major types of Continuous Variable Transmission System. The first toroidal drive is patented in 1877 by C. W. Hunt. In last 30 years there is a significant improvement in the fields of material, lubrication fluids, tribology and control. Usage of CVT is especially in the automotive industry, as they offer the potential for an improvement in fuel economy virtual to discrete ratio transmissions. This arises from the ability to match the engine operating point more beneficially to vehicle needs as a result of the continuous ratio range. The grip continuously variable transmission (CVT) drives has sustained to be an object of considerable research interest inside the mechanical design community, driven mainly by automotive industry's demands for more energy efficient and environmentally vehicles friendlier. The continuously variable transmission, although a pretty new innovation to the automobile industries, the main advantage and appeal of the CVT is the fact that there are infinite amounts of gear ratios among a maximum as well as a minimum (there are no gears in the CVT; however the term gear ratio is still used for what it represents).

II. BASIC THEORY OF TOROIDAL CVT

Some say you can't teach an old dog new trick. But the continuously variable transmission (CVT), which Leonardo da Vinci conceptualized more than 500 years ago and is now replacing planetary automatic transmissions in some automobiles, is one old dog that has definitely learned a few new tricks. Indeed, ever since the first Toroidal CVT patent was filed in 1886, the technology has been refined and improved. Today, several car manufacturers, including General Motors, Audi, Honda and Nissan, are designing their drive trains around CVTs. An summary of the chronological background of the continuously variable transmission (CVT) has been introduced, among them, principally two types that are of interest in the automotive area, viz, half 'Toroidal' traction drives and full-'Toroidal' traction drives which are shown in Figure.1 and Figure.2 .

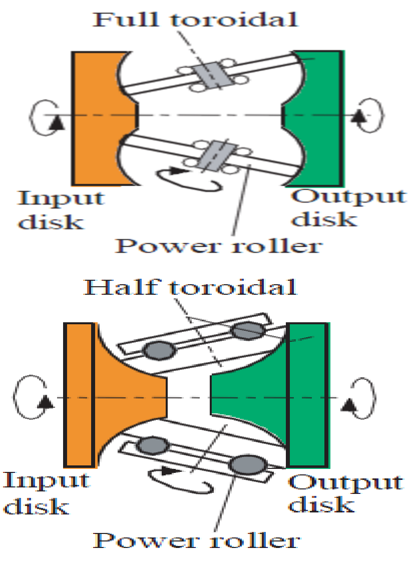

Fig.1 Toroidal type CVT

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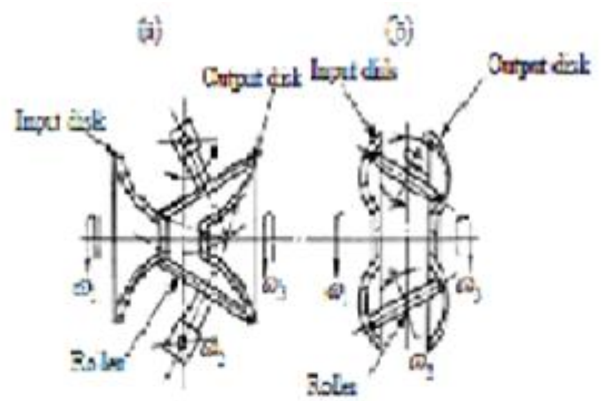


Fig. 2 Configuration of 'Totoidal' traction drive CVT:

(a) Half Toroidal (b) Full Toroidal

Continuously Variable Transmission (CVT) is a transmission scheme through improved fuel efficiency, quieter process, as well as a lower mass. Current efforts to decrease the vehicles fuel consumption in order to defend the environment as well as keep fuel have seen a recent resurgence in CVT research, particularly in the automotive permit a continuous variation of the output velocity via adjusting its geometrical configuration.

The Toroidal category Continuous Variable Transmission System has simple component arrays; they are made of discs as well as rollers so as to transmit power among the discs. The discs can be pictured as two almost conical parts, point to point; through the sides dished such to the two parts could fill the central hole of a torus. One disc is the input, and the other is the output. Among the discs are rollers which vary the ratio and which transfer power from one side to the other. While the roller's axis is perpendicular to the axis of the near-conical parts, it contacts the near-conical parts at same-diameter locations and therefore gives a 1:1 gear ratio.

It allows an infinitely variable ratio change within a finite range, thereby allowing the engine to continuously operate in its mainly efficient or else highest performance range. With a Continuous Variable Transmission System we by no means feel the transmission shift while driving and it changes adapting to the driving condition. CVT's provide powerful driving performance via continually eliciting high engine power, owing to the fact that minimal power loss occurs during ratio changes.

Infinitely variable speed is available above a given range in the continuous variable transmission system. Dual friction drive specifically two friction surfaces in contact which increases the torque transmitting capacity of the continuous variable transmission system.

III. CONSTRUCTION

In our attempt to design a special purpose machine we have adopted a very a very careful approach, the total design work has been divided into two parts mainly;

- System design
- Mechanical design

System design mainly concerns with the various physical constraints and ergonomics, space requirements, arrangement of various components on the main frame of machine no of controls position of these controls ease of maintenance scope of further improvement; height of machine from ground etc.

In Mechanical design the components are categorized in two parts.

- Design parts
- Parts to be purchased.

For design parts detail design is done and dimensions thus obtained are compared to next highest dimension which are readily available in market this simplifies the assembly as well as post production servicing work.

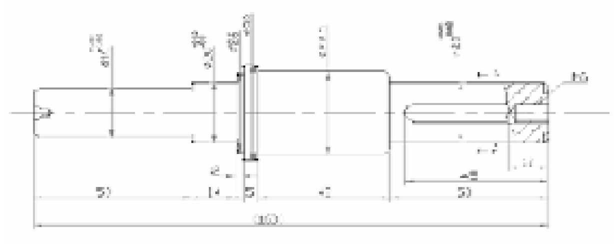
A. Motor

Motor has following specifications:

Single phase AC motor
Commentator motor
TEFC construction
Power = 120 watt
Speed= 0-6000 rpm (variable)

B. Input Shaft

Input shaft is a high grade steel (EN 36) construction coupled to motor at one end and keyed to the input friction bowl at the other. It is held in heavy duty ball bearing (6204) at the casing.



C. Input Friction Bowl

Input friction bowl is similar to friction disc, but is modified in construction that a spherical recess is turned on the face of this disc whose inner surface serves as the friction surface. This friction bowl drives the friction discs at the two ends held between swivelling forks.

D. Friction Disk

A pair of friction disk lined with friction material on the circumferential face is mounted on respective swiveling forks. A bronze bushing is placed

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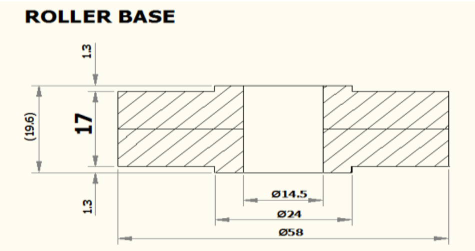
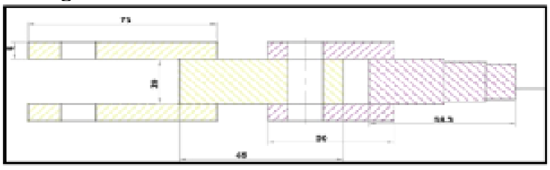
between the rollers and fork pin to minimize frictional losses and wear.



E. Swiveling Forks

Swiveling forks are holding members that house the friction disks. These forks can be swiveled about their axes to permit angular disposition of the disks with respect to friction bowl axes forks are held in bush bearings mounted in the casing. The forks also carry driving pinions that enable to rotation of the forks to desired angle.

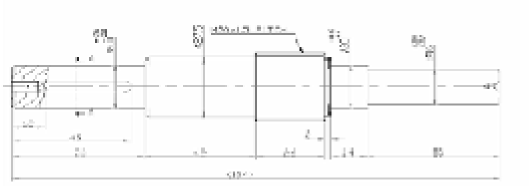


F. Output Friction Bowl

Output friction bowl is a driven member made of aluminium similar to the input friction bowl. It is keyed to the output shaft.

G. Output shaft

Output shaft is a high grade steel (EN36) which is keyed to output friction bowl at one end and to the load at the ether end. It is housed in the heavy duty ball bearing (6204) housed in the casing.



IV. MECHANICAL DESIGN

In mechanical design the components are listed down and stored on the basis of their procurement in two categories,

- Design parts
- Parts to be purchased

In mechanical design at the first stage selection of appropriate material for the part to be designed for specific application is done.

A. Design of Spur Gear

Power = 120 watt
Speed = 6000 rpm
b = 8 m
No.of teeth on pinion = 12
No. of teeth on Gear = 60
Reduction ratio (i) = 5
Gear speed = 6000/5 =1200
Material of pinion and gear [High grade industrial (polyamide) (trade name : Nylon 66)]
Tensile strength =82 N/mm^2
T= 0.95 N-m
Considering 25% overload
Tdesign = 1.25T = 1.19 N.m
S_{ULT}pinion=S_{ULT} gear= 82 N/mm^2
Service factor (Cs) = 1.5
dg = 60
Peff = 135.2N
W_T= 161.15 m^2
And so selecting standard module =1.0 mm

B. Gear Data

No. of teeth on pinion =12
Module = 1.0 mm
No. of teeth on gear =60

C. Design of Input Toroid Hub

Smallest section on the hub (ref. dwg.) has the following dimensions
Outside dia =25 mm
Inside diameter = 20 mm

D. Design of Output Shaft

Material selection: Ref: PSG (1.10 & 1.12) + (1.17)

Designation	Ultimate Tensile Strength N/mm^2	Yeild Strength N/mm^2
EN 24	800	680

E. Design of Key

Selecting parallel key from standard data book for given application .

For Shaft Diameter	Above upto	17 22
Key cross section	Width Height	5 5

F. Design of Output Toroid Hub

The output is supplied from output toroid hub mounted on the output shaft top output shaft by means of keyway . Output toroid is hollow shaft

hence design of the output toroid hub is done as hollow shaft
Smallest section on the hub (ref. dwg.) has the following dimensions
Outside diameter =25 mm
Inside diameter = 18 mm

G. Selection of Bearing

Shaft bearing will be subjected to purely medium radial and axial loads; hence we shall use ball bearings for our application.
Selecting; Single Row deep groove ball bearing as 6004ZZ, 6003ZZ, 6002ZZ

H. Design of Power Rollers

Power rollers are hollow shafts that transmit power from input toroidal hub to output toroidalhub .
Smallest section on the rollers (ref. dwg.) has the following dimensions
Outside dia =46 mm
Inside diameter = 35 mm

V. TEST AND TRIAL ON TOROIDAL CVT

To conduct trial

a) Torque Vs Speed Characteristics
b) Power Vs Speed Characteristics
c) Efficiency Vs speed characteristic

In order to conduct trial, an dynobrake pulley cord, weight pan are provided on the output shaft.

A. Input Data

1) Drive Motor
AC230 Volt
0.5 Amp, 50 watt
0 TO 9000 RPM
TEFC MOTOR
2) Diameter (Effective) of Dynobrake pulley = 65 mm.

B. Procedure

1) Start motor by turning electronic speed variator knob.
2) Let mechanism run & stabilize at certain speed (say 660 rpm)
3) Place the pulley cord on dynobrake pulley and add 100 gm weight into, the pan , note down the output speed for this load by means of tachometer.
4) Add another 10 gm weight & take reading .
5) Tabulate the readings in the observation table.

VI. OBSERVATION TABLE

SR NO	LOADING	
	WEIGHT (kg)	SPEED rpm
01	0.1	660
02	0.2	651
03	0.3	640
04	0.4	610
05	0.5	629
06	0.6	510
07	0.7	405

A. Result Table

Sr No.	LOAD (kg)	SPEED (RPM)	TORQUE (N.M)	POWER (watt)	EFFICIENCY
1	0.1	660	0.031	2.20	15.74
2	0.2	651	0.06	4.34	31.05
3	0.3	640	0.09	6.41	45.79
4	0.4	610	0.12	8.14	58.19
5	0.5	629	0.15	10.50	75.01
6	0.6	510	0.19	10.23	72.98
7	0.7	405	0.22	9.46	67.61

VII. CONCLUSION

For contacts of the half toroidal CVT, the critical point of the maximum Hertzian stress is at the maximum deceleration position, i.e., at the initial rotation angle of power roller. The different system parameters play the major role in developing the Hertzian stress in the contacts of the half toroidal CVT. For systems with high input torques, the average maximum Hertzian stresses show higher values than those having low input torques within the speed ratio range. While, the average maximum Hertzian stresses show lower values for systems with high values of aspect ratios, curvature ratios, power roller cone angles and maximum traction coefficient. In addition, the selection of the combination material with a moderate modulus of elasticity is preferable which reduce the maximum Hertzian stress to avoid fatigue failure. Useful graphs relating with material, operating and geometrical parameters are of help for a designer to determine the maximum

Hertzian stresses within the speed ratio range in such systems.

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