Ball Traction Transmission

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***Abstract*—Now-a-days, manufacturing industries use constant speed ratio where stepped reduction and enhancement of speeds is used. The concept of 'Ball Traction transmission', allows variable speed outputs which helps in precise manufacturing of any component avoiding a cumbersome process.**

Keywords—Motion; Stepless; Drives; Disc; Ball; Design; Speeds; Variable.

I. INTRODUCTION

Machine tools are complex machines that produce various components of desired shape, size and accuracy by metal removal processes from the work piece for which a relative motion between the tool and the job is necessary. This relative motion moulds the work piece in the desired shape and size.

There are two types of cutting motions:

i) Primary Motion: This motion is the basic motion provided to the tool so that the face of the tool approaches the work piece material, manually or by power transmission. Primary motion is provided to remove the metal or the chip on the work piece. Two types of motions i.e. cutting motion and feed motion are included in it. It usually absorbs a small portion of total power required for the entire machining operation. When feed motion is added to primary motion there is repeated or continuous removal of chips on the work piece which results in desired shape, size and geometry of the work piece. The speed of the cutting motion depends on the optimal cutting speed where as the feed movement depends upon the degree of surface finish which varies according to the requirement of the job.

ii) Auxiliary motion: There is no direct removal of metal due to this motion but it helps in machining process to be carried out smoothly. It includes non-cutting motions which are to be carried out as fast as possible. Following motions come under auxiliary motion:
   - Loading and unloading of the job
   - Clamping and unclamping of the job
   - Set up motion according to shape and size
   - Controlling the motion according to cutting process.
   - Adjusts the machine tool according to the required speed and feed.
   - To fix and release particular machine member that can be performed either manually or automatically.[4]

Machine Tool Drives are broadly classification of as follows:

1. Stepped Speed Drives in Machine Tools
   - Belting
   - Pick-Off Gears
   - Gear boxes
     - AP &GP for steeping speeds of gears
     - Structural formula & structural diagrams
2. Feed gear boxes
3. Steeples Speed Drives in Machine Tools. [3]

II. PRINCIPLE OF OPERATION

A. Free Ball Traction Drive

Free Ball Traction Drive includes two conical discs or cones, one for input and the other for output which can also be called as driver or driven disc. It also includes a spherical ball and a speed setting knob. The output disc is also called as friction disc. [1]

B. Construction and working

Fig. 1 shows 'Ball Traction Drive' whose construction is as follows:

(1) Shows an adjustable spherical ball made of steel which is placed between two axially displaced conical discs (2 & 3) that helps to transmit power from input disc (2) to Output disc (3). Primarily the main source of power is the motor which with the help of belt and pulley mechanism transmits power to the input disc (2). As soon as the load is applied the ball gets into the triangle shaped area which is formed in between the discs by the same amount of which the elastic deformation of the parts is occurred. Here the Torque dependent pressure devices are not necessary as the contact pressure is directly proportional to the output torque.

Contact Pressure ∝ Output Torque

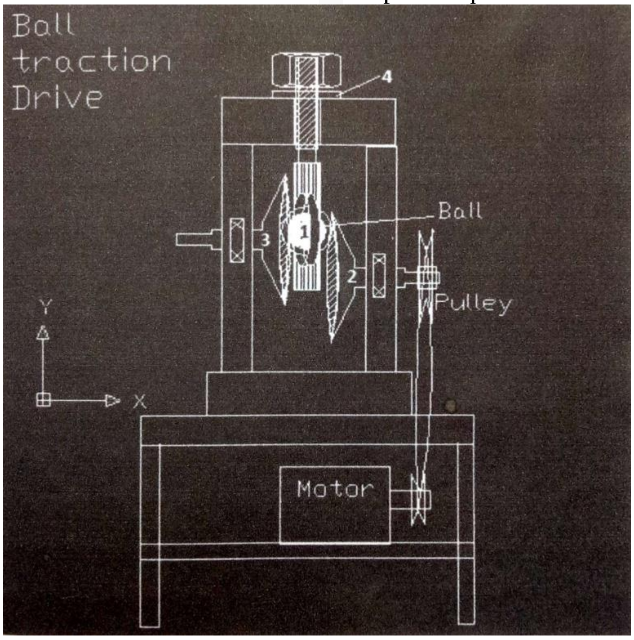

Fig. 1 Ball Traction Drive

The ball is free to rotate in either direction (Clockwise or counterclockwise) and the position of the ball (1) can be adjusted with the help of the speed setting knob (4) due to which we get infinitely variable output speeds. The knob can be adjusted when the machine is in motion as well as at rest. Hence the setting time is reduced. Uppermost position of the knob gives the ratio of 3:1 reduction, created between input and output shaft while in the lower adjustment position the ratio of 1:3 increases. 9:1 is the total speed range covered.

We can positively control the movements of the ball while adjusting the knob at higher or lower speeds. When the ball is adjusted at lower speeds the knob is moved in downward direction and due to the tendency of the ball to attain the position at higher cone (at the middle), it tries to move upward against the movement of the knob and takes an upward position. When very low input speeds are provided, a very low load must be applied so that the desired output speeds are achieved. [1]

III. DESIGN AND EXPERIMENTAL SETUP

Design approach includes make and buy decisions, materials used, dimensions of the components, specifications of the components to buy, design of shaft, selection of ball bearing as per requirement. The set up that we have prepared is based on mere assumptions and predictions and also considering the feasibility of the components available in market.

A. Design of Driver Motor

TYPE: SINGLE PHASE AC MOTOR

POWER: 1/15HP (50 WATTS)

VOLTAGE: 230V, 50Hz

CURRENT: 0.5A

SPEED: 1440rpm (max)

OPERATING SPEED: 1440rpm

MOTOR TORQUE:

$P= (2*\pi*NT) \div 60$

$T= (50*60) \div (2*\pi*1440)$

T= 0.33 Nm

Power is transmitted from the motor shaft to the input shaft of drive by means of an open belt drive.

Motor pulley diameter= 20mm

IP-shaft pulley diameter= 110mm

Reduction ratio= 4

IP-shaft speed= 1440/4 = 360rpm

Torque at IP shaft= 4*0.33 = 1.32 Nm

MATERIAL SELECTION OF SHAFT:

DESIGNATION= EN24

ULTIMATE TENSILE STRENGTH= 800N/mm^2

YIELD STRENGTH= 680N/mm^2

B. Design of Shaft

Referring to American Society of Mechanical Engineers (ASME) design of shaft is done. Since the load on the shaft is mainly due to the machinery which is not constant, it is very necessary to take proper tolerances and allowance in order to bear the load fluctuations.

According to ASME code permissible values of shear stress (f_s) may be calculated from the following relations:

$f_{s\ max} = 0.18 * f_{ut}$ (ultimate tensile strength)

$= 0.18 * 800$

$= 144$N/mm^2

OR

$f_{s\ max} = 0.3 * f_{yt}$ (yield strength)

$= 0.3 * 680$

$= 204$N/mm^2

Considering the minimum value:

$f_{s\ max} = 144$N/mm^2

This is the allowable value of shear stress (f_s) that can be used in the shaft material for safe operation.

The input shaft is driven by the motor by means of an open belt pulley hence the input shaft carries a pulley at its one end which is fasted with the help of grub screw to it. Hence it should have a sliding fit on it. To achieve the tolerance of h6H7 on the pulley we need to bore the pulley hole & the minimum hole possible is 16mm, so adopting the shaft diameter 16mm.

C. Selection of Ball Bearing

The system design of the drive is the main governing factor in the selection of ball bearing (size of the ball bearing is of major importance). Hence we shall first select an appropriate ball bearing taking into consideration convenience of mounting the planetary pins and then we shall check the actual life of ball bearing.

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TABLE I. SELECTION OF BEARING

Bearing basic design No.	D	D_1	B	Basic Load Rating (N)	
				C	C_o
6204	20	47	14	1200	6200
6205	25	52	15	14000	6950

D. Experimental Setup

The experimental setup that we prepared with the help of the above design calculations is shown in Fig 2 below

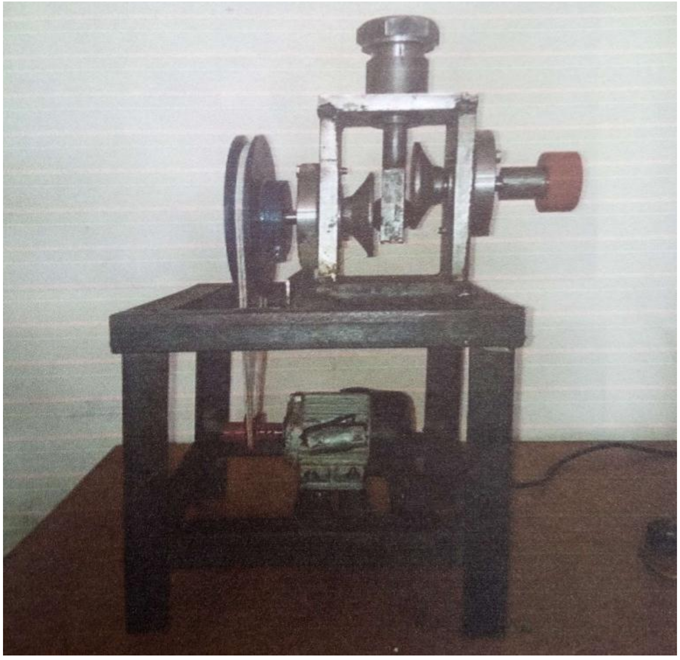

Fig. 2 Experimental Setup

IV. RESULTS

The tabular and graphical representation of the results is given below:

A. Tabular Representation

Table II represents the output speeds (rpm) of the disc at different loads. A constant input speed of 340rpm is provided for getting variable output speeds at 250grams and 750grams load whereas for 1150grams of load, 320rpm constant speed is supplied. Here are the results carried out by the setup in Fig. 3

TABLE II. OUTPUT SPEEDS FOR DIFFERENT LOADS

Sr. No.	No. of rotation of dial	Output Speed at load 250 grams	Output Speed at load 750 grams	Output Speed at load 1150 grams
1	0	610	560	430
2	1	510	505	460
3	2	425	424	350
4	3	350	365	300
5	4	247	280	220
6	5	190	230	175
7	6	110	155	120
8	7	50	120	95
9	8	24	95	75

B. Graphical Representation

Based on the results in Table II, graphical representation of the output speeds (rpm) on ordinate and No. of rotation of dial on abscissa is as shown in Fig.3, Fig. 4 and Fig. 5

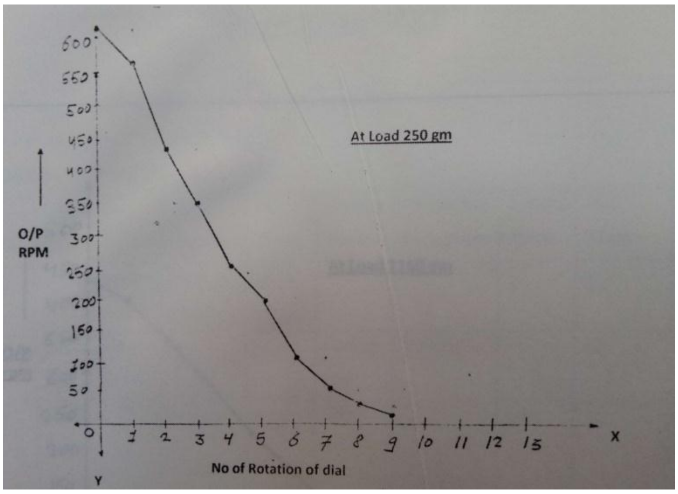

Fig. 3 Output Speed for Load 250grams

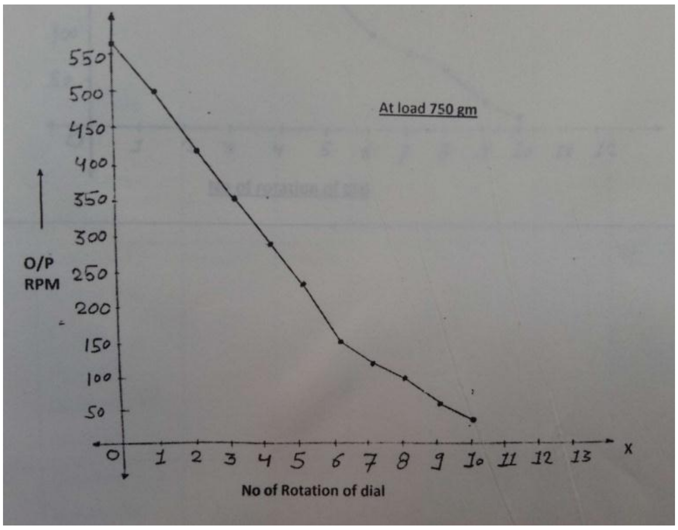

Fig. 4 Output Speeds for Load 750grams

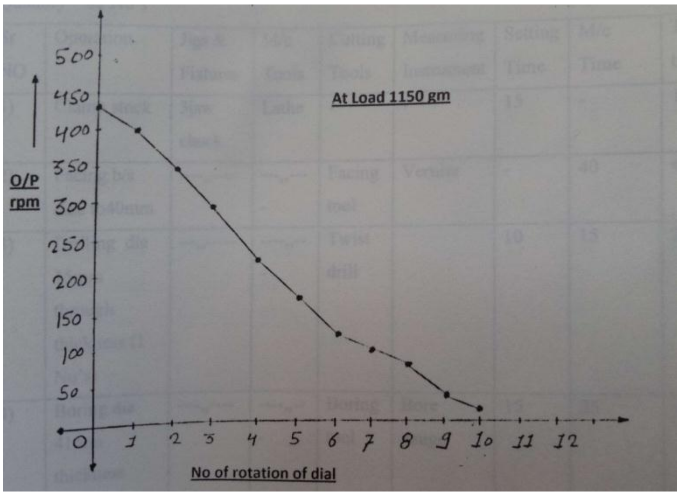

Fig. 5 Output Speeds for Load 1150grams

Looking at the graphs we can come to the conclusion that as load increases the output speed decreases slightly.

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V. ADVANTAGES

Using CVT in automotive

1. Step-less gear change eliminates Shift-shock which makes the ride smoother
2. Keeping engine in its optimum power range improves fuel efficiency
3. Less power loss in a CVT than a typical automatic transmission results in better acceleration
4. We can incorporate automated versions of mechanical clutches which replaces insufficient torque convertors
5. Responds better to changing conditions like change in throttle and speed eliminates gear hunting as car decelerates while going uphill. [2]

VI. APPLICATIONS

1. Gearless variable speed reducer can be used along with all geared headstock in machine tool spindle, to provide an infinitely variable speed.
2. By combination of Duplex friction drive and a Three stage all geared head stock still wide range of speeds can be obtained.
3. It provides variable speed drive for conveyors in material handling systems.
4. It can be used in overdrive assembly in automobiles.

VII. CONCLUSION

Power transmission system is very important in industrial applications to carry out production work at various speed, we require the stepless, shockless speed variation hence it is necessary to design and develop the power transmission system which is compact in size and most efficient along with minimum cost. From above testing we can achieve nearly 75% efficiency at high speeds

The time consuming process of shifting of gear and belt pulley is not required while varying the speed. Here the speed is varied with the help of the knob. Single ball traction drive is also used in running condition hence it is convenient to vary the speed. While changing the speed, with the help of the knob, there are no jerks and shocks experienced so continuous production is possible.

Using Ball Traction Transmission we can achieve infinitely variable speed outputs even when we supply constant speed to the input disc. Its use eliminates the complicated tumbler gear mechanism and back gear mechanism in the lathes. As per requirement we can change the dimensions and design the whole assembly according to load conditions.

REFERENCES

[1] Avinash Ashokrao Uthale, Dr. S.S. Gawade, Research Paper "PERFORMANCE INVESTIGATION OF A SINGLE BALL TRACTION DRIVE" Uthale, et al, International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974 Int. J. Adv. Engg. Res. Studies / II/ IV/ July-Sept.,2013/31-33

[2] D. S. Welkar, Prof. P. G. Damle, K.A.Patil, Review of "Free Ball traction Drive for CVT", International Journal of Research in Advent Technology, Vol.3, No.12, December 2015 E-ISSN: 2321-9637

[3] Chapter_1_Kinematics_SpeedGea_Boxand_eedGea_BoxDesign.pdf

[4] https://www.scribd.com/document/145816406/Types-of-Cutting-Motion-in-Machine-Tools (sited 20/10/2016 5:55pm)