Gearless Variable Speed Drive

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Abstract— Gearless variable of speed drive has various application in various industries. It is most suitable in Automobile industries to drive assembly line conveyors. Our specific aims were to have the variations of speed from minimum to maximum speed without any gear arrangement. The design selection began by considering a type motion materials, power system and bearing used. Scale model design, construction and testing, stress analysis and buoyancy calculations were used to decide on a final design. The final design is a operated by a lever without any speed calculations. The drive is constructed for speed of 9000 rpm. the motor used is of 1/15 h.p. The drive works very smoothly.

Indexed Terms-- Variable, gearless, speed, link, material, pulley, belt, shaft, rod, load, yoke, roller, motor

I. INTRODUCTION

1.1 TRANSMISSION SYSTEM: -

The word transmission means the whole of the mechanism that transmit both motion and power from the source of energy to the application where it is to be used. However, the transmission is also being used very commonly in literature for a mechanism which provides us with suitable variation of engine torque at the application either in the amplified or reduced form.

The basic drive for any application consists of;

- Source of energy.
- Devices for transmitting power from source to operating elements (Spindles, slides, table etc.)

Machine tools are drive by either of these drives.

- Group drive
- Individual drive.

Each drive is selected on is oven merits, but individual drives are more advantageous. In 'electrical drives the direct motor drives the machine shaft through direct coupling. In "Mechanical drive" the transmission elements include "Belts, chains, toothed gearing or some multi- or variable speed transmission".

The transmission elements between the input & output shafts can perform the following function,

a) Convert rotary motion into translatory motion.
b) Convert rotary motion into rotary motions.
c) Convert translatory motion to translatory motion.

1.2 MECHANICAL DRIVES

CONVERSION OF ROTARY MOTION TO ROTARY MOTION: -

A) BELT DRIVES

In such drives, a pulley is mounted on the drive shaft and another on the driven shaft and motion is transmitted from the drive pulley to the driven pulley with the help of belts. The section of the belts can be open or crossed. In open drive the driver and driven shafts rotate in same direction is reversed.

$$\text{Transmission ratio (i)} = \frac{\text{RPM of driven shaft.}}{\text{RPM of driver shaft}}$$

B) CHAIN DRIVES: -

Roller chain and silent chain are employed in machine tool drives. The direction of the rotation of the driving sprocket and driven sprocket is the same.

$$(i) = \frac{\text{No of teeth on the driving sprocket}}{\text{No of teeth on the driven sprocket}}$$

C) TOOTHED GEARING:
Toothed gearing serves for transmitted motion between parallel, intersecting and crossed shafts Straight tooth and helical tooth spur gears are used to connect the parallel shafts.

For intersecting shafts straight or spiral bevel gears are used for crossed shafts, worm gearing is used.

STEPPED MECHANICAL DRIVES:

With a constant speed motor, there is a need for some method of varying the speed over this range (N max-N min). In order to provide for a wide range of operating speeds together with adequate torque at lower spindle speeds, it is necessary that the spindle speeds it is necessary that the spindle speed range be covered in a number of discrete step:(stepped drives). The various stepped mechanical drives are as follows.

A) STEP-CONE PULLEY DRIVE: -

This drive gives definite steps of speed ranging from striven speed considerably less than the driver to speeds much higher than that of driver.

- The drive is simple and cheap in design but it occupies lot of space.
- Number of speed steps are limited.
- Belt drives are not positive, constant velocity ratio is not guaranteed; she to slip.
- Shining of belt also takes a lot of time.

Note:- The number of step speeds on the cone pulley arrangement can be increased using an back gear arrangement.

B) ALL GEARED DRIVES :-

All geared drives are used to remove the drawback of cone-pulley arrangement.

Different speed changing methods in this category are as follows.

A) Change gear system

- In the selection of various change gears, mounted on two shafts, sum of no of teeth
- on various gears pairs must remain constant.
- Gear ratio cannot be over 2:1 & not less than 1:4
- Change gears can be replaced only after switching off drive of the machine.

B) Clutch type drive
In this method when claw clutch is manually engages with freely mounted gears on driving shafts, motion is transmitted to the driven shafts.

- Toothed clutch can only be engaged at rest or when the relative speed of rotation does not exceed 0.7 m/sec.

C) Sliding gear type drive
A double cluster gear is shifted on a splined shaft so that it engages with one of gear on second shaft to give different speeds.

- Sliding gears may be shifted only with rotation of driving shaft is switched off.
- Maximum 2,3 or occasionally gear can be used on cluster gear.

D) Sliding key gear box Number of gears run free on shaft any one of these can be engaged with shaft by sliding key which can be axially moved to engage one of the gears

1.3 ADVANTAGES: -
1. Compact construction
2. Short length assembly.
3. Control of engagement with a single lever.

1.4 DRAWBACKS: -
1. Long & deep key warp weaken shaft.
2. Due to certain clearance between key & Keyway local bearing of key is limited; hence used for transmitted relatively small torque.

II. LITERATURE REVIEW

The literature review mainly focuses on various study already carried out for failures analysis and design optimization of similar shaft applications.

- Literature Survey

P.Hiren, et.al, [1] "design and analysis of gearless transmission mechanism using elbow mechanism". 2017 In this study gives information about the Strength, Speed, Torque Transmissibility of Elbow mechanism as this are very much important terms in defining applications of the mechanism in replacement of gears. It mainly focused on the theoretical, analytical and FEA method. Computation of various parameters like Number of pins, Material used, Dimensional difference of elements, Speed, Torque. Many previous approach were made to find out the optimum design in order to make this mechanism better then old mechanism by using different analysis software. It consist Theoretical & Analytical method for the design of elbow mechanism

Md. Abu Hasan Al Askary, et.al,[2] "performance test analysis of gearless power transmission system for four number of elbow pins" 2019 An efficient means to transmit power is important for the present socio-economic world. Usually power transmission is associated with belt, chain, gear, rope, shaft etc. from the mechanical point of view. Uses of gear for transmitting power is a popular way but noise, friction, wearing, breaking of components etc. results in power loss and lower efficiency. A real-time study of the gearless transmission mechanism which is efficient and an economical way to transmit power is presented in this paper. The system has interchangeability and low cost for manufacturing. The response of four number of elbow pins has been analyzed by SOLIDWORKS software's simulation feature for various speed between 50 to 400 rpm and the efficiency has been calculated from input and output speeds. The efficiency has been obtained nearly about 85 percent.

Jagushte G. S, et.al,[3] "design, analysis and fabrication of gearless transmission by elbow mechanism "2016 this paper represent real time study of gearless transmission mechanism. This transmission system is to be analysed in solid works software to study reaction of elbow rods and hub and then the fabrication of mechanism is carried out. The real time study is carried out by applying a motor to one of the shafts which drives the output shaft. The analysis is performed by applying the force on hub according to given Revolution per minute. Similar analysis carried out at different higher revolutions per minute and forces are applied. As a result response of elbow rod and hub investigated to find permissible speed of mechanism

Mahantesh Tanodi, et.al,[4]"Gearless Power Transmission-Offset Parallel Shaft Coupling"2014 The Gearless transmission for parallel shafts is a device for transmitting motions between the Parallel shafts. The synthesis of this mechanism would reveals that it comprises number of pins would be in between 3 to 8, if more the pins smoother the operation. These pins rotate inside hollow cylinders thus formatting a rotary pair. The Z-pins (or Z-links) are free to rotate in the holes, which are drilled parallel to the axis of shafts. The angle for which the pins are bent to must precisely the same for each one, and the holes in the shafts must be accurately drilled, both radially and tangentially. All parts of this coupler move when the shafts rotate. This is a very smooth-acting device, and the minimal power loss. It can be run at nearly any speed, even at high speed, and is very quiet. It is fascinating to watch in action, with the pins rotating in holes as it rotates. Unlike universal joints, there is no performance loss by increasing shaft offset.

S. S. Pawar, et.al,[5] "gearless transmission through elbow mechanism"2018 The transmission of power with minimum losses is the main criterion for calculating the efficiency of the machine. Most machines use gear transmission from inlet to outlet but have the most power loss due to friction. An investigation in this field has brought new ideas to transmit power using different mechanisms. This document studies and trains the new mechanism by replacing the bevel gear with a 90 ° elbow that is used to transmit power. This transmission system indicates that there is the possibility of transmitting power at a right angle without gears efficiently. In this work, the power is transmitted with six elbows connected radially at an angle of 60º to the center of the axis.

Robert G. Parker, et.al,[6] "Steady Mechanics of Belt-Pulley Systems"2010 Steady state analysis of two-pulley belt drive is conducted where the belt is modelled as a moving Euler-Bernoulli beam with bending stiffness. Other factors in the classical creep theory, such as elastic extension and Coulomb friction with the pulley, are retained, and belt inertia is

included. Inclusion of the bending stiffness leads to nonuniform distribution of the tension and speed in the belt spans and alters the belt departure points from the pulley. Solutions for these quantities are obtained by a numerical iteration method that generalizes to n-pulley systems. The governing boundary value problem (BVP), which has undetermined boundaries due to the unknown belt-pulley contact points, is first converted to a standard fixed boundary form. This form is readily solvable by general purposed BVP solvers. Bending stiffness reduces the wrap angles, improves the power efficiency, increases the span tensions, and reduces the maximum transmissible moment.

Mohsin M. Khan, et.al,[7] "Performance Evaluation of Pulley Arm Design"2016 Here in this study CAD method has been explored to design and analysis of pulley arm and belt, which considered being the main parts of a rod cutting machine. The cutting speed of a present system of pulleys and belt is very low in actual working conditions. The ultimate aim of the project is to increase the cutting speed Finite Element Analysis was done for investigation of stresses experienced by the pulley. Finite Element Method (FEM) is used to determine the BM shared by the arms for its different angular positions. The distribution of bending stress in the arms is also obtained. Finally, the design modifications have been suggested the parameters, By using this parameters the new design is developed which is able to give the cutting speed which is required for the actual working conditions. The results showed that stress experience by the pulley is less than the young's modulus of the material. This ultimately enhances the life of the pulley and belt. It is also observed that the total deformation is very less and not crossing the bounding box limits. Hence part is safe.

N . Ugesh, et.al[8] "Finite element analysis of a shaft subjected to a load"2016 The project is mainly concentrated about the analysis of a shaft with the help of a ANSYS software under workbench. In this the shaft is taken from the head stock of the lathe machine. In this analysis the shaft is connected with bearing and gear. This is the major important component to be taken into account while designing. The objective is to build a model and assemble the part files and to analyze the various stress and deformation. The part files and assembly are done by using CREO software and the analysing are done by using a ANSYS software. The static analysis is used to analyze the stress and deformation of the shaft when it is subjected to a particular load and the modal analyze is executed to govern the vibration features (mode shapes and natural frequencies) of shaft. The results obtained by the stress analysis is found to be good agreement and modal analysis i.e., vibration characteristic like frequency and mode shapes are presented are within the limit

L Bhaskara Rao, et.al,[9]"analysis and Simulation of Gearless Transmission Mechanism "2014 this paper presents the real time study of mechanism. The system is to be analysed in SolidWorks package software to watch the response of the elbow rods and the also the hub (coupled with shaft). The real time study is carried out by applying a motor to one of the shafts supported on bearings. Motion analysis is performed by running the mechanism at 15 revolutions per minute, reaction forces and reaction moment are plotted against clock run of 5 seconds by using post processor. Similar motion analysis is carried out at different higher revolutions per minute and peak values of forces and moments are taken from the plot and compared with allowable stress. Theoretical calculations are made to obtain allowable stress by making use of design data values. As a result, response of elbow rod and hub is investigated to find the permissible speed of mechanism. Further simulation is performed to verify the motion analysis results.

Mukesh Didwania, et.al,[10] "Modal analysis of drive shaft using FEA"2013 The objective of the drive shaft is to connect with the transmission shaft with the help of universal joint whose axis intersects and the rotation of one shaft about its own axis results in rotation of other shaft about its axis. The model of drive shaft has been generated in Solid works and then impored in ANSYS workbench. In this work finite element analysis of a drive shaft has been taken as a case study. In the present work the modal analysis of a drive shaft has been carried out the inherent frequencies and vibration mode shapes with their respective deformation. The maximum stress point and dangerous areas are found by the deformation analysis of drive shaft. The relationship between the frequency and the vibration modal is explained by the modal analysis of drive shaft

III. METHODOLOGY

3.1 Primary Data: -

Primary data is the first-hand information collected by there searcher for the first time Primary data is that data in which the origin proceeding primary information by interviews by discussion, by methods, by counselling was used. Discussion was field with the officers thus the staff. The information so collected is used in study.

Interview method
Questionnaire Method
Questionnaire Method of Data Collection

This method a Questionnaire is containing of questions which are asked by the Surveyor to the Respondents. A special & related questions format is prepared for this. For getting maximum, up-to-date & genuine data, a special questionnaire is the basic requirement for this research. Assent group helps me to develop this Questionnaire. Because of this team work I come to know, the expectations of the organization. This efforts result in having a multi dimensions Questionnaire. Alone with this one suggestion form is also prepare for getting the suggestions or opinions of the Industrialists.

3.2 Secondary Data:-

Secondary information is the second-hand information collected by else before which can be used in the research study& Organization to satisfy it's own need but it is been used by other department under reference for an entirely different reason.

- Office documents & Annual report of the company.
- Books, website, magazine periodicals & newspapers.

The data collected is subjected to various statistical techniques serve a meaningful finding and suggestions.

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 case of maintenance scope of further improvement; height of m/c from ground etc.

In Mechanical design the components are categorised 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.

The various tolerances on work pieces are specified in the manufacturing drawings. The process charts are prepared & passed on to the manufacturing stage. The parts are to be purchased directly are specified &selected from standard catalogues.

3.3 SYSTEM DESIGN: -

In system design we mainly concentrate on the following parameters:

1. System selection based on physical constraints:

While selecting any m/c it must be checked whether it is going to be used in large scale or small-scale industry in our case it is to be used in small scale industry So space is a major constrain. The system is to be very compact.

The mechanical design has direct norms with the system design hence the foremost job is to control the physical parameters

2. Arrangement of various components:

Keeping into view the space restriction that components should be laid such that their easy removal or servicing is possible moreover every component should be easily seen & none should be hidden every possible space is utilized in component arrangement.

3. Components of system:-

As already stated system should be compact coughs so that it can be accommodated at a corner of a room. All the moving parts should be well close l & compact A compact system gives a better look & structure.

Following are some example of this section

- Design of machine height
- Energy expenditure in hand operation
- Lighting condition of m/c

4. Chances of failure :-

The losses incurred by owner in case of failure of a component are important criteria of design. Factor of safety while doing the mechanical design is kept high so that there are less chances of failure. Periodic maintenance is required to keep the m/e trouble free.

5. Servicing facility :-

The layout of components should be such that easy servicing is possible especially those components which required frequent servicing can be easily dismantled.

6. Height of m/c from ground :-

Fore case and comfort of operator the height of me should be property decided that he may not get tired during operation. The me should be slightly higher than that the level also enough clearance be provided from ground for cleaning purpose.

7. Weight of machine :-

The total wt of m/e depends upon the selection of material components as well as dimension of components. A higher weighted mic is difficult for transportation & in case of major break down it becomes difficult to repair.

IV. CONCLUSION

In this project we have studied Gearless variable speed drive used to transmit power from one shaft to another shaft. It is also used for wide range of speed variation. Gearless variable speed drive less costly than gear drive system. requires less maintenance than gear drive as no lubrication required. By using Gearless variable speed drive shifting from one speed to another should be shock less.

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