Design and Development of kinematic linkages Variable Speed Drive

Alok Kumhar[1], Shubham Pisal[2], Dnyaneshwar Borate[3], Amit Kumbhar[4]

[1,2]*Student ,Jaywant College of Engineering and Management, K.M.Gad,Shivaji University*
[3,4]*Student Jaywant College of Engineering and Management, K.M.Gad,Shivaji University*

---***---

Abstract - *This paper presents the synthesis, analysis, and review of a variable displacement four-bar crank-rocker-slider mechanism that uses low friction pin joints instead of planar joints. The synthesis technique develops the range of motion for the base four-bar crank-rocker and creates a method of synthesizing the output slider. Kinematic Linkage Transmission is a mechanical adjustable speed drive .The speed range is infinitely adjustable from ½ to ¼ of input speed under full rated load. Speed Adjustments are easily made by moving a lever control through an arc.*

***Key Words*: Cam, Continuously Variable Transmission, Infinitely Variable Transmission, Link Mechanism, Quadric Crank Chain, Ratchet.**

INTRODUCTION

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.)

There are many machines and mechanical units that under varying circumstances make it desirable to be able to drive at an barely perceptible speed , an inter mediate speed or a high speed. Thus a infinitely variable (or steepless speed variation in which it is possible to get any desirable speed. Some mechanicals hydraulic and electrical devices serve as such stepless drives .However the torque Vs speed characteristics of these drives do not match that of stepless drives at increased driving torque at low speeds.
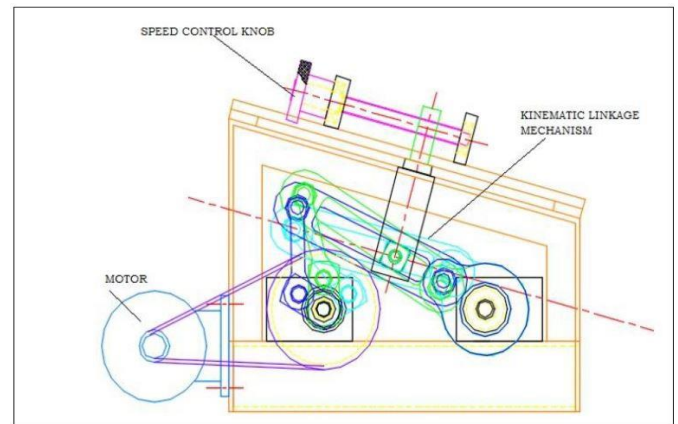
1.1 Construction and working

Fig – 1: kinematic linkages variable speed drive

This drive consists of four linkages, pulley, motor (8000rpm) and also movable screw for controlling the speed of output shaft. Whole mechanism is mounted on rigid frame and the offset linkages with120^0 to achieve continues output. The kinematic linkages works on the four bar ratcheting mechanism and the speed is vary by the speed controlling knob at third link i.e. connecting rod. The speed is vary due to constraint motion of the linkages using sliding of control link. To achieve the desired rated output the linkage control link is moved from Control link position –A to control link position –B. The Control link pivot thereby changes the degree of oscillation of the output link which is further rectified using one way clutches to get a uni-directional output.   Another unique feature of the drive being that the speed changes are step-less and hence the speed changes can be closely and precisely monitored.

Design Methodology

System design:

 System design as to kinematic design of one linkage set to 30 degree output. System Design and geometrical derivations of the linkage to integrate individual linkage output to get the desired 1:4 ratio. System Design and geometrical derivations of the control linkage to achieve single lever control and derive the desired output in step-less manner. Selection and geometrical profile of shifter mechanism. Selection and design of cam profile, linkage geometry for minimum space occupation and minimum

inertia to make drive compact, lightweight and precise. Selection of motor drive transmission.

Mechanical design:

This part includes the design and development of linkages, section dimensions for strength criterion. The linkage section dimension will be calculated using theoretical derivation using appropriate theories of failure. The components of the drive will be designed using CREO PARAMETRIC 5.0 Input eccentric, Connecting link, Output link, Control link

Design of input and output shaft

According to the maximum shear stress theory
f_{sy} =0.5 f_{yt} =300N/mm^2
The permissible shear stress is given by
Fs all = f_{yt}/fos
      =300/2 =150 N/mm^2
Section of the crank pin at xx is subjected to combined bending and torsional
Crank force = T $_{dsign}$ / eccentricity = 1.2x 10^3 /25 = 48 N
Moments
M_t = 48 x 25 =1200 N-mm
M_b = 48 x 45
   =2160 N-mm
f_b = Mb y/I
   =1080 x 32 /Π d^3
f_s =Mt r/J
   =1200x16/Π d^3
F_{max} =((fb/2) ^{2} + fs^2)^{½}
d = 3.5 mm

Design of connecting link

a) Check for failure of connecting rod under direct tensile load
Now,
F_t = Load /Area
$F_{t\ act}$ = 48/72
      =0.66 N/mm^2
As $F_{t\ act}$< $F_{t\ all}$
The link is safe under tensile load
b) Check for failure of connecting rod under direct tensile load at the eye end
This is the portion where the lever pin fits, the cross sectional area at this point is 72 mm^2
Now,
F_t = Load /Area
$F_{t\ act}$ = 48/72
      =0.66 N/mm^2
As $F_{t\ act}$< $F_{t\ all}$
The link is safe under tensile load

Design of connecting rod

Check for failure of connecting rod under direct tensile load. Now,
F_t = Load /Area
$F_{t\ act}$ = 48/146
      =0.33N/mm^2
As $F_{t\ act}$< $F_{t\ all}$
The link is safe under tensile load

Design of output yoke

Check for failure of connecting rod under direct tensile load at the eye end
This is the portion where the lever pin fits, the cross sectional area at this point is 100mm^2
Now,
F_t = Load /Area
$F_{t\ act}$ = 48/100
      =0.48N/mm^2
As $F_{t\ act}$< $F_{t\ all}$
The link is safe under tensile load

Selection of bearing

Shaft bearing will be subjected to purely medium radial loads; hence we shall use ball bearings for our application. Selecting single row deep groove ball bearing from design data book.
P = X F_r + Y F_a
For our application F_a =0
P = X F_r
As; F_r < e ⇒ X =1
P = F_r
Max radial load = F_r =48 N.
      P= 48 N
Calculation for dynamic load capacity of bearing
L= (C) ^{p} , where p= 3 for ball bearings
      P
When P for ball bearing
For m/c used for eight hour of service per day;
L_H = 12000- 20000hr
But   ; L= 60 n L_H
                  10^6
L=720 m/rev
Now; 720 = (C)^3
            48
 C= 430.21 N.
As the required dynamic capacity of bearing is less than the rated dynamic capacity of bearing. Hence the 6201bearing is selected for our application.

CONCLUSIONS

On the basis of literature survey we understand that the era of transmission of the speed and power in stepless manner has improved in many ways. These paper provide different

mechanism for transmitting speed and power using kinematic linkages. The variation of speed under the rated load is vary without any steps due to the constraint motion of the link at different position these drive can be use in the light weight vehicle and agricultural product

REFERENCES

[1] Norman H. Beachle , Andrew A. Frank ,College of Engineering University of Wisconsin, Madison ,"Continuously Variable Transmissions: Theory And Practice" August 1979

[2] William T. Beale," Automatic Transmission with Stepless, Continuously Variable Speed And Torque Ratio" Pat.2006

[3] Brian S. Andersen,"An Investigation Of A Positive Engagement Continuously Variable Transmission" August 2007

[4] Yukawa." Department of Mechanical Engineering Iwate University" 4-3-5 Ueda, Morioka, Iwate, 020-8551 (Japan)

[5] Jeffrey M. Araujo, Michael A. DeMalia, Christopher M. Lambusta, "Switch-Mode Continuously Variable Transmission "ME-JDV-0902 , April 2009

[6] Derek Frei Lahr," Continuously Variable Transmission With External Cam"U.S. Pat.(2011) 7,878,935

[7] Shawn R. Wilhelm, James D. Van de Ven," Design and Testing of an Adjustable Linkage for and Robotics, November 2013,Vol.5

[8] Dennis W. Hong, Derek F. Lahr." The Operation and Kinematic Analysis Of A Novel Cam-Based Infinitely Variable Transmission.September 2006

[9] Jiten Patel, G.K. Ananthasuresh." A kinematic theory for radially foldable planar linkages" January 2007.

[10] Wayne Paul Bishop, Wilmington DE(US)."Positive Drive Infinitely Variable Transmission" U.S. Pat.2011

[11] Avinash A. Kawale, Dr. F.B.Sayyad, Design and Development of Stepless Variable Speed Kinematic Linkage Drive, ISSN: 2321-0869 (O) 2454-4698 (P), Volume-3, Issue-10, October 2015