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Review and Study of Adjustable Spherical Drive for Right Angle Transmission

S. V. Gite[1], Prof. E. R. Deore[2]
Department of Mechanical Engineering[1, 2], S. S. V. P. S. Bapusaheb Shivajirao Deore College of Engineering, Dhule [1, 2]
Email:mel08svg@gmail.com[1],erdmech@yahoo.com[2]

Abstract-The paper describes a new system of mechanical spherical friction drive. In the present a row of devices use for power transmission such as simple friction, belt, chain, gear and differential variable speed drives it is found that that the bevel gears are many times the only option for power transmission at right angles. For the required range of speed variation they are altogether unfit as the desired speed ratios can only be achieved by replacing the entire pair of gears which proves uneconomical in many cases. The currently used power transmissions are of low efficiency (60–70%). Therefore the better power transmission efficiency is required. Thus for requirements where multiple speed ratios are of prime importance the adjustable spherical drives come as a handy option where in the desired speed ratios are achieve by use of a single lever control more over the real output kinematical characteristic can be easily measured and calibrated. The paper deals with presentation of concept as to problem definition and approach to problem and arrangements of components as to achieve the desired power transmission and also selection of friction material for drive.

Index Terms-Friction wheel, Right Angle Spherical Drive

1. INTRODUCTION

There are many machines and mechanical units that under varying circumstances make it desirable to be able to drive at a barely perceptible speed, an intermediate speed or a high speed. Thus an infinitely variable (step-less) speed variation in which it is possible to get any desirable speed. Some mechanical, hydraulic, drives serve as such step-less drives. However the torque Vs speed characteristic of these drives does not match torque at low speeds. Hence the need of a step-less or infinitely variable speed drives with following characteristic: -

1) Step-less or infinitely varying speed.
2) Wide range of speed variation i.e. (N_{max} - N_{min}).
3) Shifting from one speed to another should be shock less.
4) Minimum number of controls for speed changing.
5) Ease of operation.

Step-less or infinitely variable main and feed drives have found considerable applications in modern machine tools. Their main advantages are as follows. The possibility of setting up the optimum cutting conditions (speed & feeds) with higher accuracy than with a stepped drive and the possibility of changing speeds of the main drive or feeds without stopping the machine. The step-less drives are of mechanical, electrical, hydraulic or combined drive. They have their own advantages and disadvantages. The selection will depend upon purpose of machine, range ratio power required & cost. In many applications it is desirable to have a transmission at right angle but at multiple speeds; in these cases the velocity ratio need not be constant. Using bevel gears for such application is not possible because each bevel gear pair will only give a single output where as it desirable to have multiple speeds more ever the design and development of a gear box with multiple speeds incurs considerable cost so also the speeds available will be in certain steps. In order to effect a single speed change one will need a bevel pinion, a bevel gear, and a control lever i.e., three parameters per speed change. More ever it is also not possible to have an in line constant mesh or sliding mesh bevel gear box as in case of spur gears, due to fact that bevel pairs are always generated in pairs, hence every new speed ratio will need an fresh pair of bevel gears. This makes the construction of a multispeed bevel gear box complicated and bulky. Needless to say the bevel gear box in this case will be high in weight and cost. Hence the need of a multi speed right angle drive with a singular control.

2. SCOPE OF STUDY

Objective of study is to study, design, develop and carry out kinematic and strength analysis of a adjustable spherical drive to provide variable speed

power transmission at right angles. The drive will be designed to provide step less speed variation at right angle by use of a single control lever. The range of speed covered can be easily achieved by merely turning the control lever. Kinematic analysis by graphical overlay method using 2-D CAD will be done and test rig will be developed for experimental validation of the same.

The critical components of drive such as the input shaft, friction rollers, sphere, and output shaft will be modeled using Uni-graphics software and strength analysis will be done using ANSYS software.

So also performance analysis of the drive will be done in order to plot the drive characteristic curves such as torque Vs Speed, Power Vs Speed, and efficiency Vs speed with fiber reinforced asbestos as the friction material.

3. PRINCIPLE OF OPERATION

Motor drives input shaft 'A'. The input shaft is vertically mounted in bearing housing. At the lower end of the shaft a circular friction disk 'B' keyed to it. This friction disk is lined with friction material. A spherical roller 'C' is mounted on an inclined shaft that is secured in the central clamp. The central clamp is further mounted on an horizontal shaft which provides for the speed adjustment The spherical roller drives another friction disk 'D' mounted on the output shaft 'E' and there by power is transmitted at right angles.

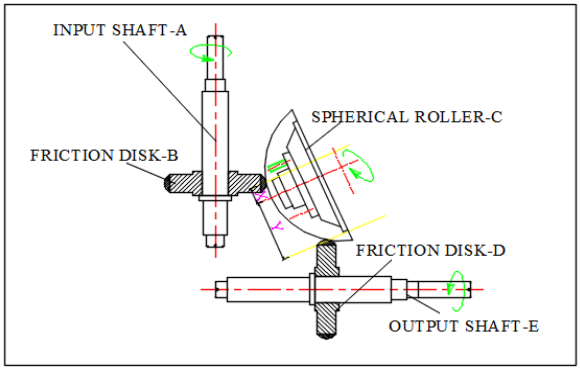

Fig. 1 Principle operation of variable speed drive

Basis of kinematic analysis for speed variation will as shown below:

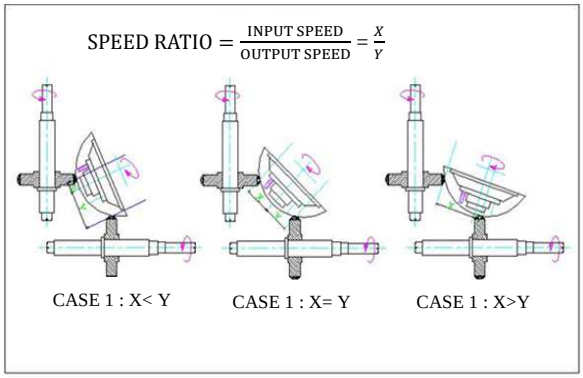

Fig. 2 Principle operation of Adjustable Right Angle Spherical Drive

The theoretical values of output speed as per kinematic analysis will be tabulated and compared to the actual values by experimental analysis and the difference in output will be termed and plotted as % Slip Vs speed to evaluate the exact performance of drive.

4. PROPOSED METHODOLOGY

To present the comprehensive literature survey and its critical study on step less right angle transmission drives to design and develop the system components of spherical drive for step-less transmission at right angles selection of appropriate drive and friction material for maximum power transmission , with minimal wear and maximum life and better heat dissipation. Testing and trial of the right angle spherical drive to derive the performance characteristic of the drive namely, Torque Vs Speed, Output power Vs Speed, Efficiency of Transmission Vs Speed and % slip Vs speed. Study of various transmission drives in the step-less friction form using various machine tool drive handbooks, United State Patent documents, Technical papers System Design part includes the design and development for the kinematic linkage as per the geometry to produce the desired step-less speed change effect. Mechanical Design part includes the design and development of linkages, selection of suitable drive motor, strength analysis of various components under the given system of forces. Suitable manufacturing methods will be employed to fabricate the components and then assemble the test set –up.

5. TESTING

Testing activity will be done with view to comment on the capability of the machine as regards to the power transmission ability, efficiency and friction material life.

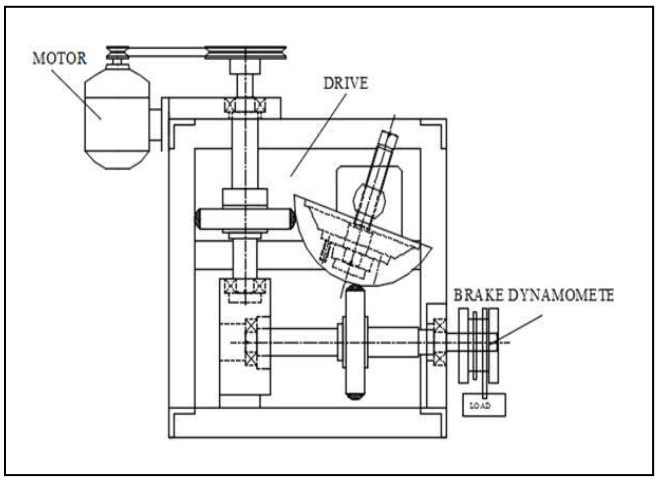

Fig. 3 Adjustable Right Angle Spherical Drive

6. RESULTS AND DISCUSSION

Conclusion will be drawn on the basis of theoretical and experimental results. Testing and trial of the right angle spherical drive to derive the performance characteristic of the drive namely, Torque Vs Speed, Output power Vs Speed, Efficiency of Transmission Vs Speed and % slip Vs speed. Thus the derived data from testing and analysis will be further used to propose the drive for different applications and its suitability for different conditions of operation.

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