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Study, Design and Analysis of Indexing Geneva wheel to achieve Intermittent Motion

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ABSTRACT

This paper grants a kinematic study of a mechanism including a Geneva wheel and a gear train to complete intermittent motion. The area of this mechanism is to remove the acceleration jump at the start and end of the Geneva wheel motion. An epitrochoidal track substitutes the circular track for the driving pin in a usual Geneva wheel drive. The epitrochoidal track is caused using a gear train and outcomes in zero velocity, acceleration, and jerk at the beginning and end of the Geneva wheel motion. Obtainable is an evaluation of the position, velocity, acceleration, and jerk between the usual Geneva wheel mechanism and the future mechanism. Afterward, the motion of the Geneva wheel is modified by presenting a non-circular gear pair to regulate the timing of the epitrochoidal path. The motion of the non-circular gear pair is resolute by reducing the extreme jerk of the Geneva wheel. One task of a mechanical designer is to synthesize a mechanism that achieves a particular task. Synthesis procedures are usually classified as either function generation, path generation, or motion generation. Cams, gears, and linkages can be combined where a point on one of the links traces a general planar curve. Planar path generation can be central to the kinematic design of a Geneva wheel mechanism. The available literature documenting mechanism synthesis for planar path generation is enormous. An introduction to mechanism design is provided by Erdman and Sandor, Waldron and Kinzel, and Uicker et al.

Key words: Turret, Lathe, Indexing head, Geneva Wheel

INTRODUCTION

The turret is a form of metal working lathe that is used for repetitive production of duplicate parts, which by the nature of their cutting process are usually interchangeable. It evolved from earlier lathes with the addition of the turret, which is an index able tool holder that allows multiple cutting operations to be performed, each with a different cutting tool, in easy, rapid succession, with no need for the operator to perform set-up tasks in between, such as installing or uninstalling tools, nor to control the tool path. The latter is due to the tool path's being controlled by the machine, either in jig-like fashion, via the mechanical limits placed on it by the turret's slide and stops, or electronically directed servomechanisms for computer numerical control lathes.

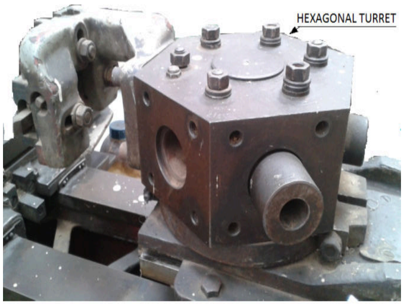

Fig. 1 Turret Head

A turret head is a vertical cylindrical revolving tool holder for bringing different tools into action successively in a machine, as in lathe.

An indexing head, also known as a dividing head or spiral head, is a specialized tool that allows a work piece to be circularly indexed; that is, easily and precisely rotated to preset angles or circular divisions.

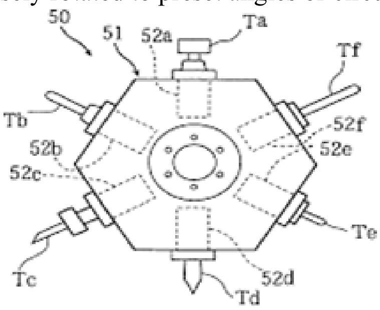

Fig. 2 Indexing Head

The Geneva is one of the earliest of all intermittent motion mechanisms and when input is in the form of continuous rotation, it is probably still the most commonly used. Geneva's are available on an off the shelf basis from several manufacturers, in a variety of sizes. They are cheaper than cams or star wheels and have adequate to good performance characteristics, depending on load factors and other design requirements.

In the most common arrangement, the driven wheel has four slots and thus advances by one step of 90 degrees for each rotation of the drive wheel. If the driven wheel has n slots, it advances by 360°/n per full rotation of the drive wheel.

Fig. 3 Geneva Wheel

LITERATURE SURVEY

Indexing Mechanism [Robert E., Machinery Handbook (25 Ed.)] Indexing in reference to motion is moving into a new position or location quickly and easily but also precisely. After a machine part has been indexed, its location is known to within a few hundredths of a millimeter, or often even to within a few thousandths of a millimeter, despite the fact that no elaborate measuring or layout was needed to establish that location. Indexing is a necessary kind of motion in many areas of mechanical engineering and machining. A part that indexes, or can be indexed, is said to be index able.

Turret head of lathe [Hartness james, Hartness Flat turret lathe manual] The turret lathe is a form of metal working lathe that is used for repetitive production of duplicate parts, which by the nature of their cutting process are usually interchangeable. It evolves from earlier lathe with the addition of turret, which is an index able tool holder that allows multiple cutting operation to be performed, each with a different cutting tool, in easy, rapid succession, with no need for the operator to perform set-up tasks in between, such as installing or uninstalling tools, nor to control the tool path.

Geneva Mechanism [Bickford, John H.] Geneva mechanism is commonly used indexing mechanism where an intermittent motion is required. The inverse Geneva mechanism, which is variation of the Geneva mechanism, is used where the wheel has to rotate in the same direction as crank. It requires less radial space and looking device can be circular segment attached to the crank that locks by wiping against a built up rim on the periphery of the wheel.

DESIGN & IMPLEMENTATION

Table-1

Specification			
Original		Model	
Turret head		Turret head	11mm*11mm
Shaft	D=50mm,l=300mm	Shaft	D=22mm,150mm
Bearing	Id=50mm,od=80mm	Bearing	Id=22mm,od=30mm
Geneva	Crank radius=120 Geneva wheel=208	Geneva	Crank radius=60 Geneva wheel=104
Motor		Motor	12v 10rpm 1nm
Bevel gears			

The Geneva wheel motion in the previous section is based on a uniform speed of the input wheel. One method for modifying the Geneva wheel motion is to use a variable speed input wheel.
This coupling of motions is balanced through the following objectives:
1. Zero velocity at engagement/disengagement of driving pin with Geneva wheel.
2. Zero acceleration at engagement/disengagement of driving pin with Geneva wheel.
3. Zero jerk at engagement/disengagement of driving pin with Geneva wheel.
4. Continuous and smooth velocity of non-circular gear pair.
5. Continuous and smooth acceleration of non-circular gear pair.
6. Continuous and smooth jerk of non-circular gear pair.

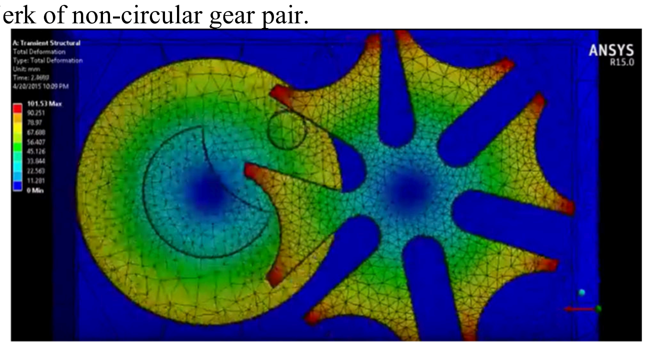

Fig. 4 Design and analysis of Geneva wheel

The analysis in Ansys defines the following points.
- The areas in red color exhibits stresses at larger level
- The areas in blue color exhibit no stresses.
- The areas ranging from red to blue shows display proportional stress.

CALCULATION

Under the condition below, the L10 life of an R-830ZZ bearing is conducted.
Basic dynamic radial load rating (cr): 553 N
Ball Diameter (Dw): 1.5875 mm
Number of ball (Z): 6
Speed in rpm (n): 3600 min-1
Radial load (Fr): 6 N
Axial load (Fa): 8 N

1. **Calculate Relative Axial Load**

$$\frac{F_a}{ZD_{W^2}} = \frac{8}{6(1.5875^2)} = 0.529$$

2. **Calculate e Value to the Relative Axial Load**

$$e = 0.22 + \frac{(0.529 - 0.345)}{(0.689 - 0.345)} \times (0.26 - 0.22) = 0.2$$

3. **Calculate the ratio of Radial and Axial Loads**

$$\frac{F_a}{F_e} = \frac{8}{6} = 1.33$$

4. **Compare the load ratio and e value**

$$\frac{F_a}{F_r} = 1.33, \quad e = 0.24$$

Therefore, $\frac{F_a}{F_r} > e$

5. **Determine X and Y**

X = 0.56

Y = 1.99 $-\frac{(0.529-0.345)}{(0.689-0.345)}(1.99-1.71) = 1.84$

6. **Calculate dynamic equivalent load**

Pr = 0.568 * 6 +1.84 * 8 = 18.08

7. **Calculate Life Hours**

$$L_{10} = \left(\frac{10^6}{60 \times 3600}\right) \times \left(\frac{553}{18.08}\right) = 13247\ h$$

Basic rating life = 132473 h

The basic static radial load and static equivalent radial load of a ball bearing are specified in JIS B 1519. Calculation method of static load rating of a ball bearing.

Fig.5 Original view of Indexing Turret in Industry

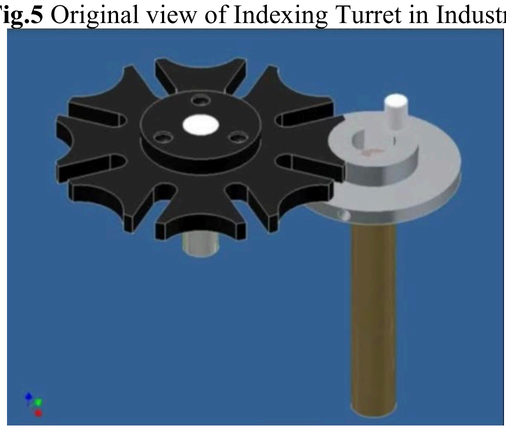

Fig. 6 CAD model of Geneva with Turret

RESULT AND CONCLUSION

This paper was designed to reduce the time required for changing the tool and indexing it automatically which was possible, the conventional capstan lathe can be transformed to turret lathe by the simple automation. The production industry now have the flexibility to upgrade the lathe machine with rising the demand of the product.

The main purpose of the mechanism was to modify and automate application of cam would change the whole concept which was indeed not feasible.

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