Design, Cad Modeling & Fabrication of Geneva Operated Roller Conveyor

Mr M. V. Ingalkar[1], Mr A. R. Sonekar[2], Mr Y. D. Bansod[3]

Lecturer in Mechanical Engineering Department

P. R. Patil Institute of Polytechnic and Technology Amravati, State Maharashtra, Country India

***Abstract* —** *The Geneva drive is a gear mechanism that translates a continuous rotation into an intermittent rotary motion. The rotating drive wheel has a pin that reaches into a slot of the driven wheel advancing it by one step. In this project we Determination of angular velocity and acceleration of Geneva wheel and also To determine the transport time of the object to cover the entire conveyor. In this project we Prepare 3D modeling of Geneva Operated Roller Conveyor by using CATIA V5 R20 Softwear*

Keywords —*CATIA {computer aided three-dimensional interactive application}*

I. Introduction

The **Geneva drive** or **Maltese cross** is a gear mechanism that translates a continuous rotation into an intermittent rotary motion. The rotating drive wheel has a pin that reaches into a slot of the driven wheel advancing it by one step. The drive wheel also has a raised circular blocking disc that locks the driven wheel in position between steps. Geneva Mechanisms are widely used in motion picture film projectors to intermittently advance film through a film gate having a projection aperture. The film is moved or advanced by a Geneva Mechanism (also known as a "Maltese Cross") until an image frame is in alignment with the projection aperture. The number of slots radially disposed around a Geneva Mechanism's star wheel is variable, and may be any whole number greater than 2. As the number of straight slots is changed, specific features of the mechanism such as component sizes, the speed and duration of the intermittent motion, and the forces or loads applied to the drive pin and star wheel, and to the load (film) all vary as well. This document is a template. An electronic copy can be downloaded from the conference website. For questions on paper guidelines, please contact the conference publications committee as indicated on the conference website. Information about final paper submission is available from the conference website.

Geneva mechanism has many applications such as in watches, projector, etc. But we used Geneva mechanism for converting rotary motion into an intermittent motion in production line. Geneva mechanism can be used in material handling in an industry. The proposed concept will help in production line where many workers are used for the material handling purpose it also reduce the cost and threshing time requirement of more number of worker will be completely eliminated as only two workers can carried out the complete operation.

I.I Project Objectives:-

- Determination of angular velocity and acceleration of Geneva wheel
- To determine the transport time of the object to cover the entire conveyor
- Prepare modeling of project on CATIA
- Transporting loads of required quantity.
- Automation with minimum man power.
- Low initial and operating cost

II. Project Methods:

This project has various different design paths to complete our product while meeting the objectives. This means we will have to implement and compare our different design to insure the best product based on our set of objectives. These paths have changed as we progressed through our project, and there were a few foreseen methods that we expand upon in the design section. The basic design for Geneva operated roller belt conveyor is to have motor on the fix stand, and then motor shaft is inserted in the center hole of drive wheel. Drive wheel is in mesh with driven wheel i.e. Geneva wheel, which is mounted on the roller shaft & belt is wound around all the rollers. When we supply electrical current to the dc motor by using adapter, then motor shaft starts rotating which further transmits the spinning motion to rollers by using Geneva wheel. The first decision is selecting bill of materials for is design path. This will help determine the ultimate product affordability. We must decide whether to use a battery or adapter to run the motor. For low upkeep we used adapter instead of battery.A more efficient yet expensive design would be to have battery instead of adapter which helps in carrying conveyor wherever we wants. There are bound to be various other obstacles and design method to be implemented as the project progresses and will be observed and recorded as they occur.

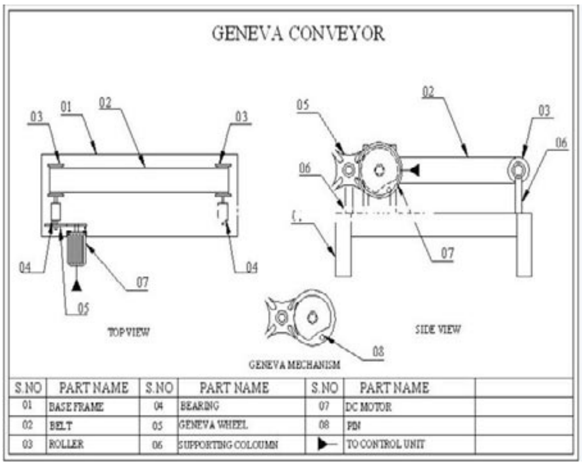


Figure 1 Block Diagram of Overall Project Design

The project main goal is to convey the material at regular interval of time as per requirement by using Geneva operated roller belt conveyor. For this project to be considered successful, a list of objectives has been determined.

II.I List of Components:-

- Motor
- Adapter
- Roller conveyor
- Stand

II.II Material Specifications

Stand:- Material = Mild Steel Hardness= 120 HB (brinell hardness) Density = 7861.093 kg/m3 Stiffness = 210,000 MPA Ultimate tensile strength =841 MPA Yield strength = 247 MPA

Belt:- Rubber Tube

Roller:- Diameter = 25mm Length =90mm Distance between two rollers = 50mm Step turning diameter = 8mm Material = Mild Steel Bearing (629ZZ):- Outer diameter =25mm Inner diameter =8mm Bore diameter = 9mm Basic load rating = Dynamic [Cr (N)] static [Cor (N)] 4566 1979 Weight = 21.8g

Geneva Wheel:- Material = Acrylics Density = 1.2g/cm3 Color = black Thickness = 3.5mm

Tensile strength = 10,000 psi (69 MPA) at room temperature Operating temperature = -300F (-340C) to +1900F (+880C) 3.3.6. Dc motor:- R.P.M. = 30

III. Design of Geneva wheel:-

The Geneva wheel, or maltese cross, is a cam like mechanism that provide intermittent rotary motion and is widely used in both low speed and high speed machinery. Although originally developed as a stop to prevent over winding of watches, it is now used extensively in automatic machinery. For example, where a spindle, turret, or worktable must be indexed. It is also used in motion- picture projectors to provide the intermittent advance of the film. A drawing of a six- slot Geneva mechanism. Notice that the centerlines of the slot and crank are mutually perpendicular at engagement and at disengagement. The crank, which usually rotates at uniform angular velocity, carries a roller to engage with the slots. During one revolution of the crank the Geneva wheel rotates a fractional part of a revolution, the amount of which is dependent upon the number of slots.

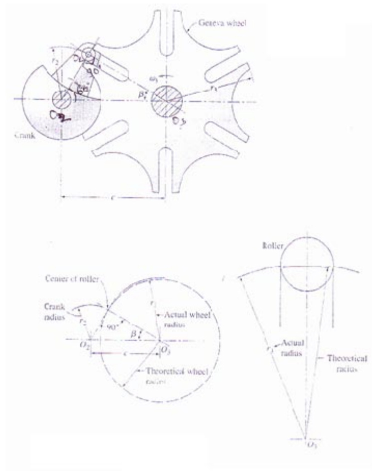
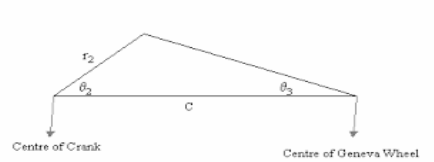


Figure 2 Design of Geneva wheel

The circular segment attached to the crank effectively locks the wheel against rotation when the roller is not in engagement and also positions the wheel for correct engagement of the roller with the next slot. The design of a Geneva mechanism is initiated by specifying the crank radius, the roller diameter, and the number of slots. At least three slots are necessary, but most problems can be solve with wheel having from four to 12 slots. The design procedure is shown in fig. The angle is half the angle subtended by adjacent slot; that is, β=360°/2n



Where n is the number of slots in the wheel. Then, defining r as the crank radius, we have

$$c = \frac{r2}{\sin(\beta)}$$

Where c is the center distance. Note, too, from fig. that the actual Geneva wheel radius is more than that which would be obtained by a zero diameter roller. This is due to the difference between the sine and the tangent of the angle subtended by the roller, measure from the wheel center. After the roller has entered the slot and is driving the wheel, the geometry is tha of figure. Here is the crank angle and is the wheel angle. They are related trigonometrically by

$$\tan\theta_3 = \frac{\sin\theta_2}{(c|r_2) - \cos\theta_2}$$

We can determine the angular velocity of the wheel for in value of by differentiating equation[c] with respect to time. This produces

$$\omega_3 = \omega_2 \frac{(C|r_2)\cos\theta_2 - 1}{1+(c^2|r_2{}^2)-2(c|r_2)\cos\theta_2}$$

The maximum wheel velocity occurs when the crank angle is zero. Substituting therefore gives

$$\omega_3 = \omega_2 \frac{r_2}{c-r_2}$$

The angular acceleration, obtained by differentiating equation with respect to time, is

$$\alpha_3 = \omega^2{}_2 \frac{(c|r_2)\sin\theta_2[1-(c^2|r_2{}^2)]}{[1+(c|r_2)^2-2(c|r_2)\cos\theta_2]^2}$$

The angular acceleration reaches a maximum where

$$\theta_2 = \cos^{-1}\left\{\pm\sqrt{\left[\frac{1+(c^2|r_2{}^2)}{4(c|r_2)}\right]^2}\right\}_{+2-} \frac{1+(c|r_2)^2}{4(c|r_2)}$$

This occurs when the roller has advanced about 30 percent into the slot.Several method have been employed to reduce the wheel acceleration in order to reduce inertia forces and the consequent wear on the sides of the slot. Among these is the idea of using a curved slot. This can reduce the acceleration, but also increased the deceleration and consequently the wear on the other side of the slot. Another method uses the Hrones-Nelson atlas for synthesis. The idea is to place the roller on the connecting of a four bar linkage. During the period in which it drives the wheel, the path of the roller should be curved and should have a low value of acceleration. Figure shows one solution and include the path taken by the roller. This is the path that sought while leafing through the book. The inverse Geneva mechanism of figure enables the wheel to rotate in the same direction as the crank and requires less radial space. The locking device is not shown, but this

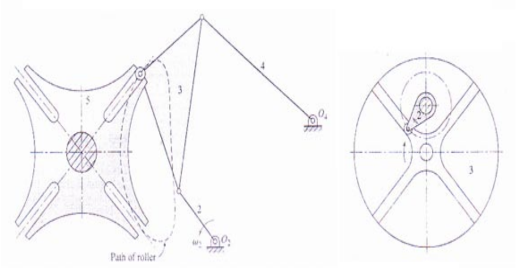
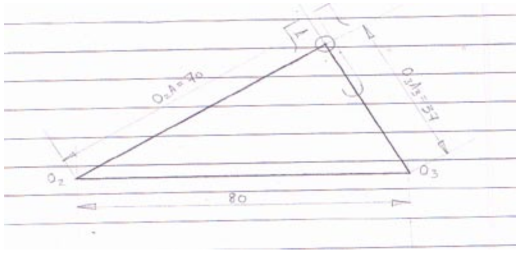
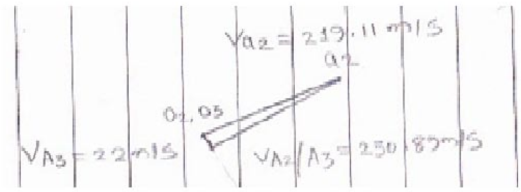


Figure 3 Inverse Geneva mechanism

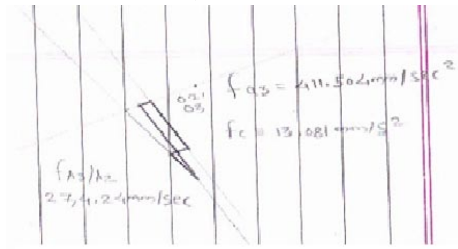
Figure Geneva wheel driven by a four bar linkage synthesized by the Hrones-Nelson atlas. Link 2 is the driving crank. Can be a circular segment attached to the crank, as before, which locks by wiping against a built up rim on the periphery of the wheel. Calculation of angular velocity and acceleration are as given below:-



Scale =1 cm = 109.95mm/sec



Scale = 1cm= 342.12mm/sec2



Acceleration diagram of six slot Geneva wheel

$$\omega = \frac{2\pi 30}{60} = 3.14 rad/sec$$

Velocity polygon,

$$V_{A2} = For\ line\ q_2 o_2$$

$$\omega_2 \times o_{A2} = 3.14 \times 70$$

=219.911mm/s =0.219m/s

For angular velocity if Geneva wheel,

$$\omega_3 = \frac{V_{A3}}{O_3 A_3} = \frac{22}{37} = 0.594 rad/sec$$

Acceleration,

$$f^t{}_{A3} + f^c{}_{A3} = f^t{}_{A2} + f^c{}_{A2} + f^s{}_{A3/A2} + f^{cr}{}_{A3/A2}$$

$$F^c{}_{A3} = \frac{(V_{A3})^2}{O_3 A_3} = \frac{(22)^2}{37} = 13.081 mm/sec^2$$

$$F^c{}_{A2} = \frac{(V_{A2})^2}{O_2 A_2} = \frac{(219.11)^2}{70} = 685.84 mm/sec^2$$

Angular acceleration of Geneva,

$$\alpha_3 = \frac{f_{A3}{}^t}{O_3 A_3} = \frac{411.504}{37}$$

$$\alpha_3 = 11.127 rad/sec^2$$

III.I MATERIAL TRANSFER TIME:-

- The length of the belt is 41.2 cm
- The time required by the material to travel this length is 41.02 sec

IV. COMPUTER AIDED MODELING

CAD modeling is used by many designers to create elaborate computerized models of objects. CAD stands for computer-aided design. In this project we use CATIA V5 R20 {computer aided three-dimensional interactive application} software for preparation of 3D solid Model.

Following figures showing the 3D solid models of various components of project by using modeling software CATIA V5R20.

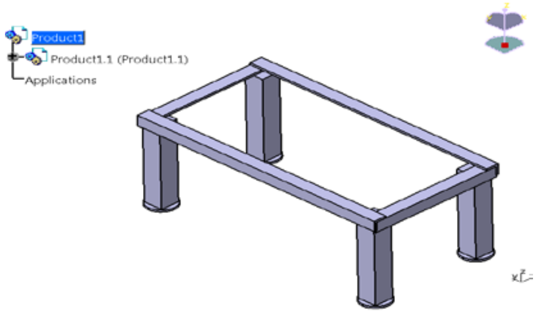


Figure 2 stand

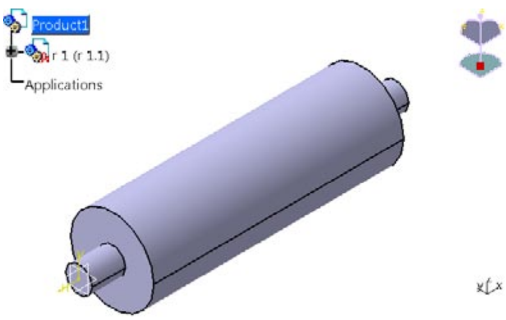


Figure 3 Roller

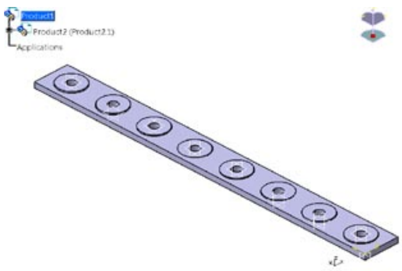


Figure 4 side plate of conveyor

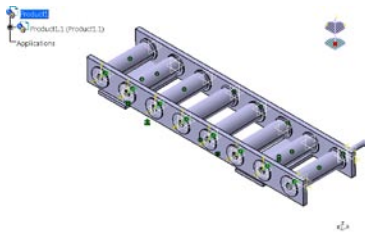


Figure 5 assembled conveyor

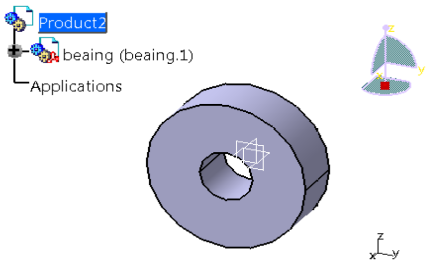


Figure 8 bearing

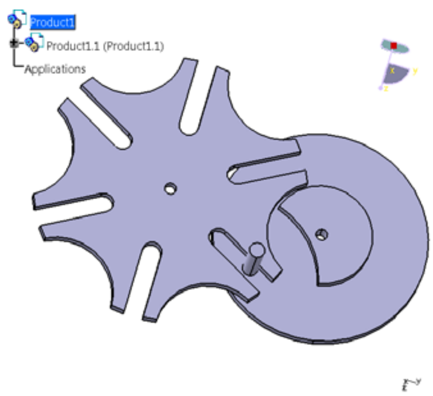


Figure 9 Geneva wheel

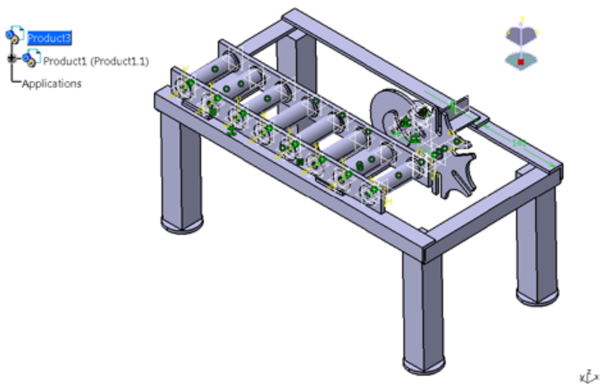


Figure 10 complete assembly

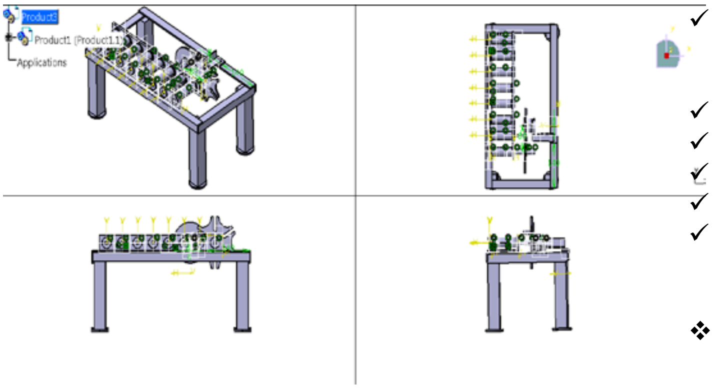


Figure 11 multi grid view

V. ADVANTAGES, DISADVANTAGES AND APPLICATION

V.I. ADVANTAGES:-

- ✓ Available in a wide variety of sizes.
- ✓ Maintains good control of its load at all times.
- ✓ Have little wear leading to a very long life span.
- ✓ Low cost.
- ✓ Saves Man Power.
- ✓ Saves time.
- ✓ Time delay can be achieved easily.
- ✓ Convey the material at regular interval of time.
- ✓ Easy setup in an industry.
- ✓ Does not require stepper motor.

V.II. DISADVANTAGES:

- ✓ Very difficult to change timing once design is chosen.
- ✓ The Geneva is not a versatile mechanism.
- ✓ The ratio of dwell period to motion is also established. Once the no of dwells per revolution has been selected.
- ✓ All Geneva acceleration curves start and end with finite acceleration & deceleration.
- ✓ This means they produce jerk.

V.III. APPLICATION:

- ✓ Modern film projectors may also use an electronically controlled indexing mechanism or stepper motor, which allows for fast-forwarding the film.
- ✓ Geneva wheels having the form of the driven wheel were also used in mechanical watches, but not in a drive, rather to limit the tension of the spring, such that it would operate only in the range where its elastic force is nearly linear.
- ✓ Geneva drive include the pen change mechanism in plotters, automated sampling devices
- ✓ Indexing tables in assembly lines, tool changers for CNC machines, and so on.
- ✓ The Iron Ring Clock uses a Geneva mechanism to provide intermittent motion to one of its rings.
- ✓ Stepper
- ✓ Mechanical watches
- ✓ Plotters
- ✓ CNC Machine
- ✓ Iron ring clocks

VI. CONCLUSION & FUTURE SCOPE:-

- ❖ We have successfully calculated the angular velocity and acceleration of the Geneva wheel. For the designed Genera wheel the and roller conveyor the time required by the material to cross the entire belt is calculated accurately. The entire modeling of the project is done with the help of CATIA V5R20.
- ❖ In addition to this. The project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is good solution to bridge the gates between institutions and industries.
- ❖ We are proud that we have completed the work with limited time successfully. “The Geneva Operated Roller Conveyor” is working with satisfactory condition. We have done to our ability and skill making ma work, let us add
- ❖ The proposed concept wills a few more lines about our impression project work. Help in production line where many workers are used for the material handling purpose it also reduce the cost and threshing time requirement of more number of worker will be completely eliminated as only two workers can carried out the complete operation. The project objective originally is to convey the material handling at regular interval of time.
- ❖ The in future the complete stress analysis of the project model could be done. This analysis could be done with the help of software called ANSYS.

REFERENCES

[1] Artobolevsky, Mechanisms in modern engineering design, Vol. III, MIR Publications Moscow, 1979.

[2] Sniegowski J. F., “Chemical Mechanical Polishing: Enhancing the manufacturability of MEMS”.

[3] Sekimoto C. "Development of Concept Design CAD System", Energy and Mechanical Research Labora