Conveyor Belt using Geneva Wheel Mechanism

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Abstract- **The Geneva mechanism 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. Geneva mechanism has many applications such as in watches, projector, etc. But we used Geneva mechanism for converting rotary motion to 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 & also reduce the cost and threshing time requirement of a greater number of workers will be eliminated as only few workers can carried out the complete operation. Generally, a belt conveyor consists of a motor to drive the rollers but in our project the belt conveyor is connected to the Geneva wheel.**

Keywords- **Geneva wheel, Intermittent rotary motion, watches, projector, threshing time, conveyor belt, Production line**

1 Introduction

The Geneva drive or Maltese cross is a mechanical assembly system that makes a comprehension of a steady transform into a broken rotating improvement. The moving drive wheel has a stick that undertakings toward an opening of the chose wheel moving it by one stage. The drive wheel likewise has a raised round blocking circle that secures the chose wheel position between steps.
Geneva Mechanisms are broadly utilized as a bit of movie film projectors to irregularly drive film through a film gateway having a projection opening. The film is moved or progressed by a Geneva Mechanism (for the most part called a "Maltese Cross") until the point that the minute that a photograph outline is in strategy with the projection opening.
The measure of spaces radially sorted out around a Geneva Mechanism's star wheel is variable, and might be any entire number more detectable than 2. As the measure of straight openings is changed, particular highlights of the structure, for example, partition sizes, the speed and navigate of the unusual advancement, and the powers or loads related with the drive stick and star wheel, and to the heap (film) all waver too. Geneva instrument has different applications, for example, in watches, projector, and so on. Regardless, we utilized Geneva fragment for changing over rotational improvement into a sporadic advancement in advance line. Geneva system can be utilized as a bit of material managing in an industry. The proposed thought will help in advance line where different laborers are utilized for the material overseeing reason it additionally diminishes the cost and separating time need of more number of expert will be totally disposed of as just two specialists can did the total development.
The Conveyor Belts are used in Industries to carry heavy objects or material from one place to another place. They are heavily used in all fields. But the conveyor belts require a lot of energy to work. Geneva drive is a gear mechanism that converts a continuous rotation into an intermittent rotatory motion. The rotating drive wheel has a small rod that reaches into a slot of wheel advancing it by one step or round. The drive wheel also has a raised circular disk used for blocking, that is it locks the wheel in position between the steps. Nowadays the conveyor made using Geneva mechanism holds a very important place in factories as the Geneva mechanism has many advantages. It is the simplest and most economical system in all intermittent motion.

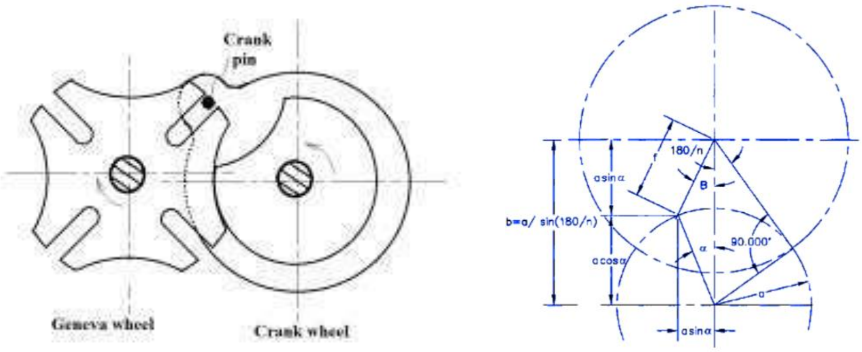


Fig 1.1 Geneva mechanism

1.1 Working of Geneva mechanism

The working of Geneva mechanism was stated earlier; a continuous rotary motion is converted into the intermittent rotary motion. The 5V DC Motor is connected with the Geneva drive wheel. The voltage of the motor is being monitored and supplied by the DC power supply. To control the direction of the rotation of motor, without changing the way that the leads are connected, an H-Bridge circuit can be used. An Arduino microcontroller or a regulator (rheostat) can be used to vary the speed of motor. The Geneva drive wheel consists of a pin and the Geneva driven wheel consisting of 4 slots. When Voltage is applied to the motor, it rotates, making the drive wheel rotate as well. When the pin of drive wheel inserts in a slot of the driven wheel, it causes the latter to rotate. The

Geneva driven wheel is coupled to a crowned flat belt pulley. When the driven wheel rotates, this pulley also rotates and as the pulley at the other end of the belt is free to rotate as well, motion is induced in the belt. Hence, an object placed on the belt can now be transferred from one position to the other.

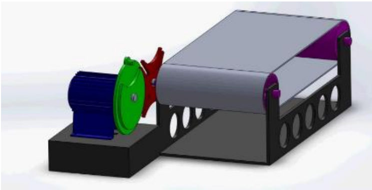


Fig. 1.2 Mini conveyor using Geneva mechanism

1.2 Types of Geneva mechanism

1.2.1 External Geneva mechanism

The external Geneva consists of a driver and driven. The driving wheel consists of a pin and a driven wheel consists of a slot. When the driver pin reaches into slot and that advances a by one step at a time. The typical figure 1.2 shows the external Geneva mechanism. The external form is the more common, as a can be built smaller and can withstand higher mechanical stresses

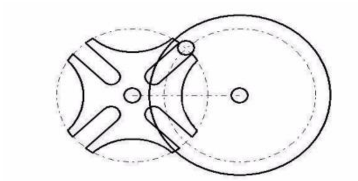


Fig. 1.3 External Geneva mechanism

1.2.2 Internal Geneva mechanism

The internal Geneva mechanism is a variant on the design. The axis of the drive wheel of the internal drive can have a bearing only on one side. The angle by which the drive wheel has to rotate to effect one step rotation of the driven wheel is always smaller than 180 degrees in an external Geneva drive and always greater than 180 degrees is an internal one, where the switch time is therefore greater than the time the driven wheel stands still.

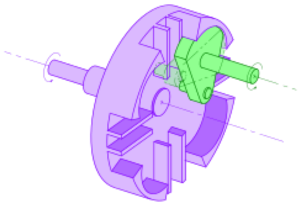


Fig.1.4 Internal Geneva mechanism

1.2.3 Spherical Geneva mechanism

In this type of mechanism, the Geneva cross is in spherical shape and cam drive are connected in externally, which is extremely rare. The driver and driven wheel are on perpendicular shafts. The duration dwell is exactly 180 degrees of driver rotation.

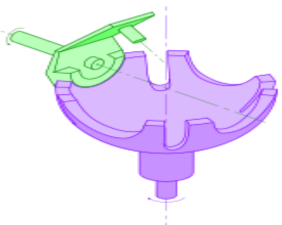


Fig.1.5 Spherical Geneva mechanism

1.3 Introduction of Belt Conveyor

A conveyor belt is the carrying median of a belt conveyor system. A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys, with an endless loop of carrying medium the conveyor belt that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler pulley.

There are two main industrial classes of bet conveyors. Those in general material handling such as those moving boxes along inside a factory and bulk material handling such as those used to transport large volumes of resources and agricultural material, such as grain, salt, coal, ore, sand, overburden and more.

Belt conveyors are universally used in industrial settings and in packaging and assembling units. They can help in transportation of regular and irregularly shaped items from one point to another regardless of their weight. The items can travel in a horizontal, declined or inclined manner, depending on the type of belt conveyor used. They are placed on the surface of the conveyor and transported from one point to the other through continuous or intermittent or nonstop movement.

The belt conveyor comprises of a belt that rests on top of a smooth metal bed or rollers. When the distance is long, belt conveyors with rollers are most suitable option, as the rollers help to reduce friction. It is not necessary for belt conveyors to be straight. They also can turn corners with a special attachment. In such a case the shape of the belt corners will be concentric, to facilitate smooth movement around the corners.

1.4 Types of Belt conveyors

There are many types of conveyors and companies should be able to find one to suit their needs.

Some of the most common types are discussed below

1.4.1 Roller Belt conveyor

As the name suggests, the surface of this type of conveyor belt is made up of rollers that are selected to match production requirements, such as the weight or required speed of the products that will move along the belt. Shorter conveyor belts that fall under this type can be made up of just two rollers. However, as the distance between the two ends of the belt increases, more will be needed for the belt to function.

A roller bed setup is suitable for when items are loaded onto the belt with gravity. This is because manual loading can cause mechanical shock and damage the rollers. Roller bed conveyor belts are also a good option for transporting items over long distances as they reduce friction, making it easier for products to move along the belt.

Fig. 1.6 Roller Belt conveyor

1.4.2 Flat Belt Conveyors

The flat belt conveyor belt is one of the most prevalent conveyor systems in use today. Flat belts are useful for internal conveyance, i.e., transporting items within a facility. This type of conveyor belt uses a series of powered pulleys to move a continuous flat belt, which can consist either of natural material or synthetic fabric (ex. polyester, nylon). Items are placed on top of the moving belt and carried from one end to the other. Since its belts can be made of different kinds of materials, this type of conveyor belt is incredibly versatile. Optional features include center drives and nose bars depending on the requirements of a given application.

Fig. 1.7 Flat Belt conveyor

1.5 Components and its functions

1.5.1 Driving arm: The driving arm is a long structure where one end is connected to the shaft of the motor and another end has a pin that goes into the slot of the Geneva driven which facilitates the rotation of the Geneva wheel. As the motor shaft rotates the arm also rotates and therefore the pin present in the arm inserts into the slot provided in the Geneva wheel making the wheel to rotate a step at a time. Hence, the pin controls the Geneva wheel.

Fig. 3.2 Driving arm

3.2.2 Geneva driven: It is a portion of a Geneva mechanism that is driven. Its surface is covered with slots. A pin is located on the driving wheel. The pin enters into the slot and advances it one step at a time while rotating. The width of the slots should be more than the diameter of the pin.

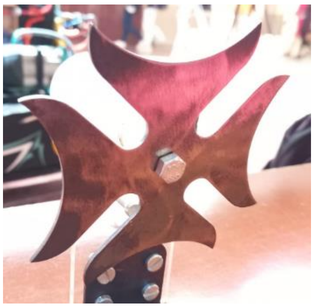


Fig. 3.3 Geneva wheel

3.2.3 Rollers: It's a spinning cylinder that revolves around a central axis. The rollers are usually shaped like cylinders. The rollers are used to move material from one location to another on the conveyor. The rollers are driven by the Geneva wheel, as the Geneva wheel rotates, it facilitates the rollers to rotate.

Fig. 3.4 Roller

3.2.4 Bearing: A bearing is a mechanical component that decreases friction between moving parts by restricting relative motion to only the desired motion. The bearing's design may, for example, allow for free linear movement of the moving part or free rotation around a fixed axis, or it may inhibit motion by controlling the normal force vectors acting on the moving parts. By reducing friction, most bearings make it easier to achieve the desired motion.

Bearings are classed based on the type of operation the allowable motions, or the directions of the loads (forces) applied to the parts.

Fig. 3.5 Bearings

3.2.5 Stand: Is the bottom component that bears the weight of all the other components. The rest of the components are attached to the base. The base material must be able to withstand the load imparted to it, and the stand material must be able to withstand the load.

Fig.3.6 Supporting stand

3.2.6 Belt: It is a fundamental tool in the material handling business. The most typical application for belt conveyors is the conveyance of bulk commodities. Two or more pulleys are used in belt conveyor systems. A continuous loop of medium-duty conveyor belt spins around them. One or both pulleys are motorized to move the belt and the material. The drive pulley is the powered pulley, and the idler pulley is the unpowered pulley. Conveyor belts are made of either PVC or rubber, depending on the intended function. One or more layers of material make up the belt. In ordinary material handling, most belts have two layers.

Carcass refers to the underlayer, which gives linear strength and shape, and cover refers to the top layer. The carcass is usually made of polyester, nylon, or cotton, while the cover is made of a range of rubber or plastic compounds required using the belt.

Fig. 3.7 Conveyor belt

3.2.7 Fasteners

A fastener is a non-permanent or permanent mechanical tool that rigidly connects or affixes two surfaces or objects together. Non-permanent fasteners can easily be removed without damaging the joined materials. The removal of permanent fasteners might require substantial force and might damage the connected surfaces. Permanent fasteners are designed to be a long-lasting form of secure connection.

The wide range of fasteners includes screws, nails, nuts, bolts, and washers that come in different sizes, types, and configurations. Fasteners are one of the most used tools for building, fabricating, and configuring a variety of products and industrial equipment.

Fig. 3.8 Fasteners

4 Formulae used for design of the mechanism

4.1Length of the Belt Conveyor:

$$L = \frac{D_L + D_S}{2}\pi + 2C \dots\dots (4.1)$$

D_L: large pulley's diameter.

D_S: small pulley diameter.

C: centre of D to centre to d

4.2The torque to find the power of motor required:

$$T = \frac{F \times D}{2} \dots\dots\dots (4.2)$$

D_L: Pulley diameter

F: Force of moving direction

We will need to calculate force (F), first before we have to calculate the load torque(T)

$$F = F_A + mg(sin\theta + \mu cos\theta) \dots\dots (4.3)$$

g: Acceleration due to gravity

F_A: External force

μ : Friction force

m: Total mass

θ : Tilt angle

Then the equation will be,

$$T = \frac{1}{2}D[F_A + mg(sin\theta + \mu cos\theta)] \dots\dots (4.4)$$

4.3Power of motor

$$P = T \times \omega \dots\dots (4.5)$$

T: torque

ω : angular velocity

4.4 Diameter of the shaft

$$d = \sqrt[3]{T \times \frac{16}{\pi\tau}} \dots\dots\dots (4.6)$$

τ : permissible shear stress

4.5Stresses for round shafts:

$$\sigma_a = K_f \frac{32M_a}{\pi d^3} \qquad \sigma_m = K_f \frac{32M_m}{\pi d^3} \qquad \text{.........(4.7)}$$

$$\tau_a = K_{fs} \frac{16T_a}{\pi d^3} \qquad \tau_m = K_{fs} \frac{16T_m}{\pi d^3} \qquad \text{.......... (4.8)}$$

Combinec

$$\sigma'_a = (\sigma_a^2 + 3\tau_a^2)^{1/2} = \left[\left(\frac{32K_f M_a}{\pi d^3}\right)^2 + 3\left(\frac{16K_{fs} T_a}{\pi d^3}\right)^2\right]^{1/2} \qquad \text{.......... (4.9)}$$

$$\sigma'_m = (\sigma_m^2 + 3\tau_m^2)^{1/2} = \left[\left(\frac{32K_f M_m}{\pi d^3}\right)^2 + 3\left(\frac{16K_{fs} T_m}{\pi d^3}\right)^2\right]^{1/2} \qquad \text{.......... (4.10)}$$

4.2 Steps involved in the design process

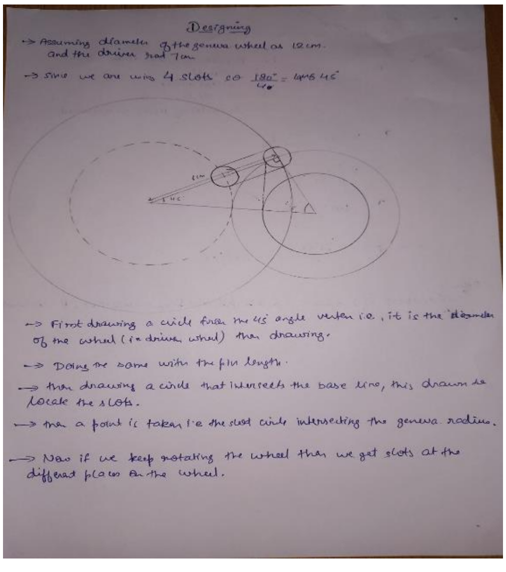
Step 1: Start from a Triangle
A Geneva drive has 3 main components - Geneva wheel, drive wheel, and drive pin. The triangle is the linkage of the 3 parts. To design a Geneva wheel with the wheel diameter 1" and 4 slots. Started with a right triangle with the right angle on the top. The left angle =180º / the quantity of slots, for example, to make 4 slots. The angle = 180º/4 = 45º.

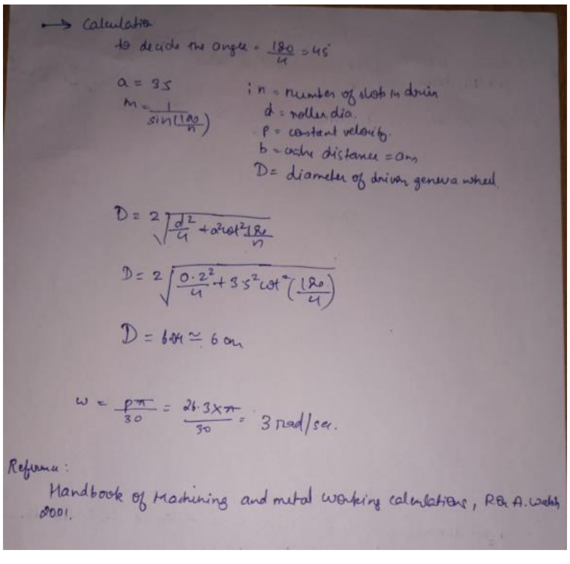
Step 2: Diameters of the Geneva Wheel and the Drive Wheel
On the right triangle, draw 2 circles centred at the 2 vertexes of sharp angles that tangent to both legs. The circle centred at the 45º angle is the diameter of the Geneva wheel, and the other is the radius of the drive pin crank. Draw another circle centred at the vertex of the 36º angle and tangent to the right circle. The tangent point is the maximum depth (how close to the centre the slots need to be) of each slot.

Step 3: Locate the Slots and Drive Pin
Decide the drive pin dimeter. For Geneva wheel ,12 cm diameter is used, so it's safe to use 0.2" in the slots design for some clearance. Draw 2 circles centred at both Intersections of the left leg and the left 2 circles. The one closer to the centre is the end of the slot, and the farther one is the where the drive pin should be. Draw a centre-to-centre slot.

Step 4: The Drive Wheel.
Select the slot and the unwanted arc of the drive wheel, use circular pattern tool to copy 5 at the left vertex.

Step 6: Make the Driver arm.
On the interaction of drive pin radius and cathetus, draw another circle same diameter as the drive pin. To connect the pin the drive wheel, you can make a bigger wheel that concentric to the drive wheel, or simply connect them with a crank. Anyway, the left end of the crank shouldn't be too close to the left vertex (unless you don't want to make it in the real world.





4.3 Dimensions and specifications

DCV motor	72 rpm, 3.5 rad/sec
Geneva wheel	12 cm diameter made up of cast iron
Roller	Synthetic plastic
Conveyor belt	48 cm length, Flat conveyor
Joints	Cast iron
Fasteners	0.8 cm diameter of stainless steel
Base plate	22 × 25 cm of resin material
Insulated cable wire	Insulated polyvinyl chloride material

Table 4.1 Dimensions and specifications of components

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