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Analysis and Synthesis of Geneva Wheel for Automation of Conventional Paper Cutting Machine

Rachit Patel[1], Tushar Gundarneeya[2]
[1,2]*PG student CAD/CAM GEC-Dahod*

Abstract: ***Trying out design and manufacturing of Geneva wheel with help of laser cutting machines for jerk less and intermediate motion. Geneva drive is an indexing mechanism that converts continues motion to intermittent motion. Due to which paper roll's paper is moved between the intervals of cutting period. Then the paper cutting is achieved by cutter which is operated with same rpm motor as same as motor which drive the Geneva driving wheel . The cutter will be back its original position by spring effect or with the help of connecting rod. So we can get same size paper pieces. This paper piece is move other side by continuous rolling conveyor to packing box.***
With help of different rpm we can get cutting piece and on the base of its quality and cutting time we can find its efficiency we can achieve optimum rpm of cutting a one cycle and achieve best efficiency of machine.
Keywords: Geneva wheel, paper piece, cutting cycle

I. INTRODUCTION

Company is mainly produce the duplex paper rolls. But in small scale and very small scale industry, they not have cutter machine. So they suggest company to make stander size paper parts. Company is not purchase the automatic paper cutting or hydraulic paper cutting machine due to financial conditions. So company recruit more man power for manual cutting. Worker first mark on paper roll and then cut the paper by cutter which is operated by his hand.

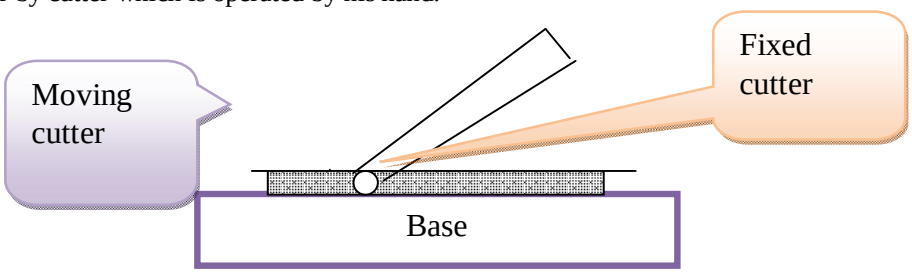

Figure-1 Manual cutter machine

As per the requirement Company make paper piece in 8 main different size in length. These length size is 375mm to 3150mm. For these 8 cutting line 8 workers are required. Their production rate is up to 200-220 pieces/hours individually. So with help of 8 worker's only 1600-1760 pieces are produced in one hours. These production rate is not sufficient in now a days.

	One day salary	*One month salary*	*One year salary*
8 Workers	*8*250=2000Rs*	*8*250*26=52,000Rs*	*6,24,000Rs*

Table 1. – worker's cost estimation

So this is main problem of company to pay these salary to workers and less production rate of paper pieces. So I suggest them to automatic cutting method. Which will reduce the man power and with help of machine we can get more production rate of paper pieces. They told me that first you make design and working model in front of them and after that they will apply in company.
Thus to design and manufacturing of automatic paper cutting machine with low budget is my main problem during the year.

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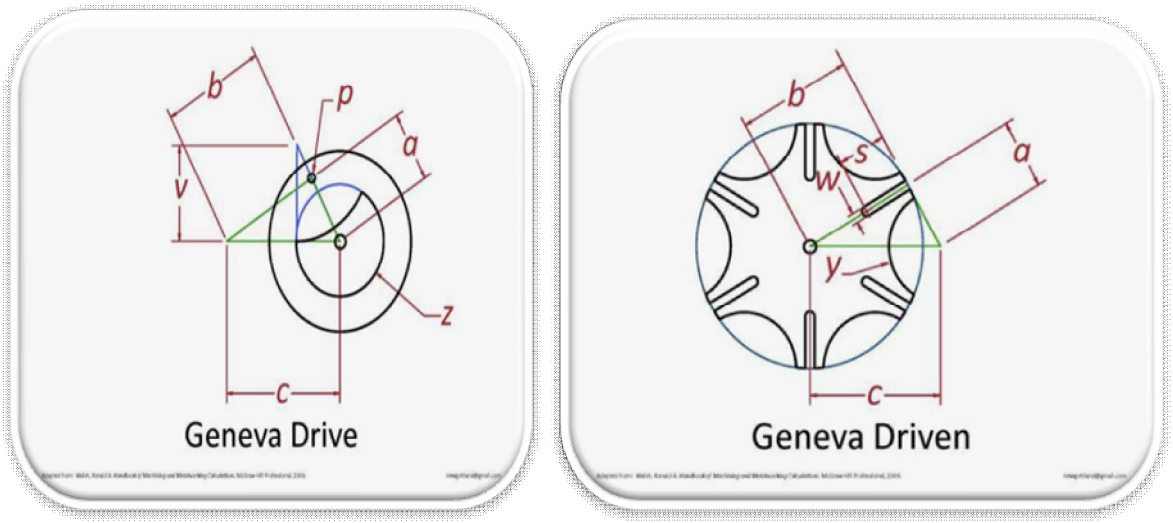
II. LITERATURE REVIEW

Geneva mechanism involve less jerk in operation and less cost of manufacturing. dijksman et al[2] discuss that with help of geneva wheel the output motion was jerk less. meter et al[3] conclude that geneva can be used as timing device and small variation in parameters of system will not affected the geneva wheel motion. hasty et al[5] analysis the geneva mechanism while it will rotating. after that he conclude that at 800 rpm, 5 slots geneva work properly. sujan et a[7] design geneva wheel and for 6 slots of geneva he found only 0.0014 deg/s3 jerk value. stanasel et al[9] generate virtual manufacturing of geneva wheel. he conclude that with help of cnc program geneva will made. for the best result external radius of geneva wheel is 92.387mm. ujam [10] develop a test ring uses geneva wheel to index a table for bottle washing purpose. he first designed test ring then constructed the test set up. with help of test ring he test so many time for different rpm of motor and find the washing efficiency. for the 5 rpm speed he found 81.57% efficiency and found 19 rpm and get 96.89% efficiency. he found 2.434 seconds as washing time.

III. METHODOLOGY

A. Basic Geometry of Geneva Wheel is as under.



c-center distance	b-Geneva wheel radius	z-stop arc radius
v-clearance arc	p-driver pin diameter	a-driver crank radius
c-center distance	b-Geneva wheel radius	a-driver crank radius
s-slot center length	y-stop arc radius	w-slot width

Now for over case, Figure 2-Geometry of Geneva wheel

b= Geneva wheel radius

$$b=-\frac{2\sin^2\emptyset}{\cos(\emptyset+\beta)}$$ where $\emptyset$ =Groove in angle [12]

$$\emptyset=\pi\left(\frac{1+\delta}{2}-\delta\tau\right)$$

$$\emptyset=\pi\left(\frac{1+1}{2}-0.45\right)$$

$$\emptyset=0.55\,\pi$$

Where δ =Geneva Co-efficient (for outer Geneva δ=1)

τ=Geneva Kinematic Co-efficient

τ =0.45(for 6 slots and outer Geneva)

Put all above value in equation of Geneva wheel radius we can get,

b=15.06cm

b=150.6mm

c=center distance between driving and driven wheel

$$c=\frac{b}{\cos(\frac{180}{n})}=\frac{150}{\cos(\frac{180}{6})}$$ where n= number of slots

c=173.21 mm

a=drive crank radius

$a=\sqrt{(c^2-b^2)}=\sqrt{(173.21^2-150^2)}$

a=86.61 mm

s= slots center length

s=(a+b)-c=(86.61+150)-173.21

s=63.39 mm

p=pin diameter

Take p=10mm for our case

t=allowed clearance

Assume t=0.5mm

w=slots width

w=p+t=10+0.5

w=10.5 mm

y=stop arc radius

$y=a-p^{1.5}=86.61-10^{1.5}$

y=54.98 mm

z=stop disk radius

z=y-t=54.98-0.5

z=54.48 mm

v=clearance arc

$v=(b*z)/a=\frac{150*54.48}{86.61}$

v=94.36 mm

B. Other Component Selection and Design for Model

Roller Dimensions

Length of paper cutting =1/n(rotation of roller) where n=number of Geneva slots

=1/6(perimeter of roller)

=1/6($2\pi r$)

Here we are using motor of 10 rpm.

If we required length of cutting paper is 40mm then,

One rotation of roller=6*40 where 6 is number of slots

Perimeter of roller=240

$2\pi r = 240$ where r is radius of roller

Radius of roller is38.21 mm

Length of paper cut in one minute=rpm *length of paper cut

=10*40

=400mm

Length of roller is dependent on the width of paper. Company is use there are 4 type of paper in width. So width of roller is take asper required in case.

Here we can use M.S material for the roller.

Motors for Driving shaft of Geneva and for giving moment to cutter

Initial we use 10 rpm DC motor For driving of Geneva Shaft and giving moment for it. We Use same rpm motor for driving cutter to synchronization purpose.

Cutter is use to cut the paper while paper is moved ahead with help of the Geneva wheel and roller. Cutter moves with help of shaft

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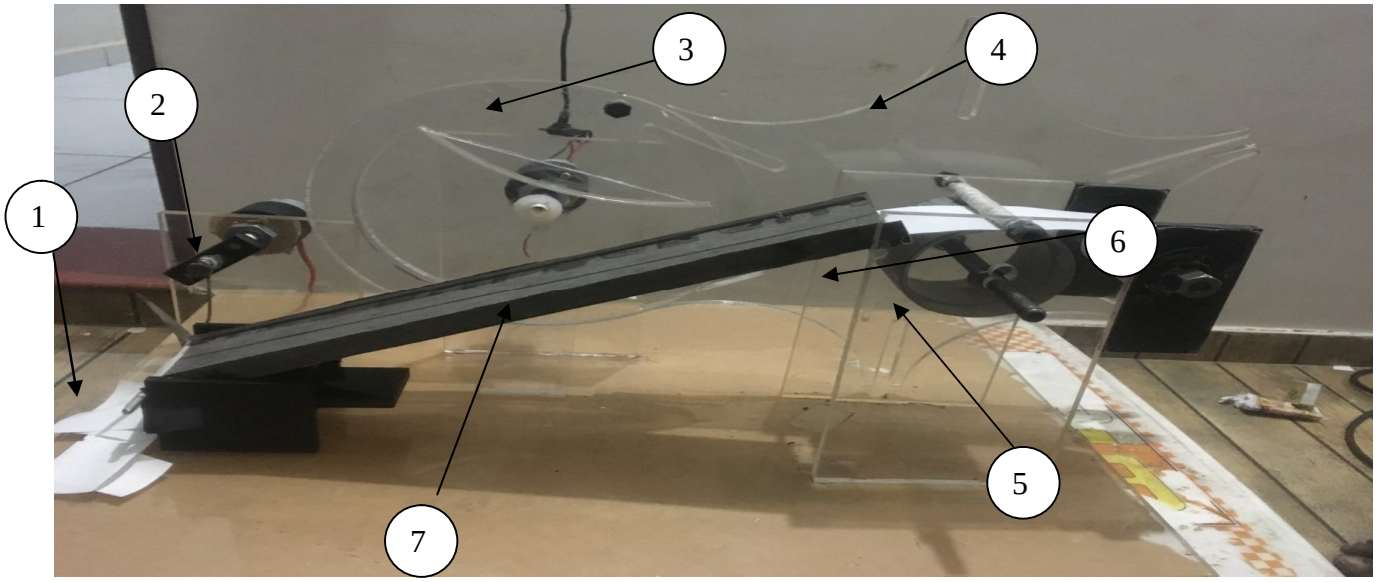
which is moved with the motor as same rpm of the Geneva wheel motor. Cutter is made of S.S Material and fixed with table so one arm is fixed and other arm is rotated with motor to shaft. So paper is cut in between two arm of cutter

Supporting shaft to provide gripe between paper and roller surface

Supporting shaft is provide the friction in between the roller and the paper. So for every turn of roller paper is moved ahead with the roller due to grip with supporting shaft. So this is main work of it.

IV. EXPERIMENTAL WORK

For the purpose of experimental work I made a prototype of paper cutting machine. In the below figure 3 front view and of prototype is shown.



1- paper cutter 2- Driving motor for cutter 3- Driving wheel of Geneva mechanism 4- Driven wheel of Geneva mechanism 5- Roller which is connected on Geneva Driven wheel shaft 6- supporting shaft which prove grip 7- supporting structure for paper

Figure 3- Front view of prototype

With these set up I work with different rpm as input with variable circuit and from that I found 15 rpm as optimum. For that I make bill of material which is 43,000Rs and from that I found break-even analysis and 170 days are b.e.p. as figure 4

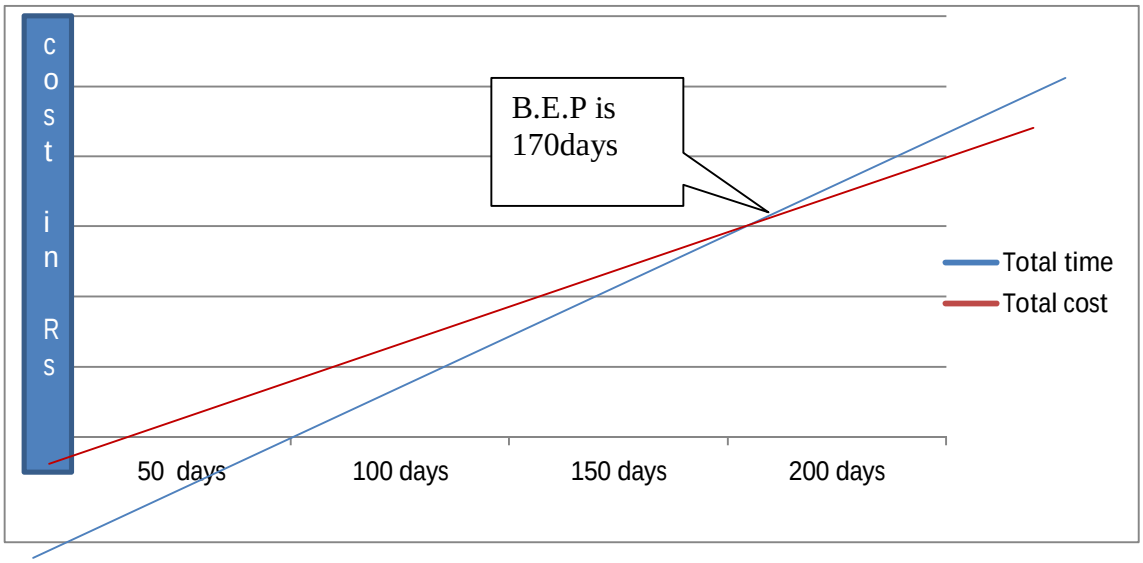


Figure 4 –Break even chart

V. CONCLUSIONS

We can get the intermittent motion with help of Geneva wheel mechanism having 6 slots and very less jerk value. It is vary simple in design and construction so that it is apply for small scale industries for automation purpose. Experimental set up or prototype of machine is designed , constructed , assembled and then use to run the experimental study. With help of variable speed input for the motors test was conducted with different rpm and from these up to 15 rpm the test was successfully. So that 15 rpm was optimum rpm at which we have best output.

For 15 rpm we got 2.64 sec as cutting time and 1.36 sec as dwell time for the machine. We got 309% more production rate compare to manual cutting machine. And Break-even point for the machine was 170 days if industry's M.D. will allow to fix these machine in industry.

Automatic cutting machine remove man power so that chance of error are very less and production rate was higher. Also we got best cutting quality of paper pieces. These solution may apply to many small scale industries for automation purpose.

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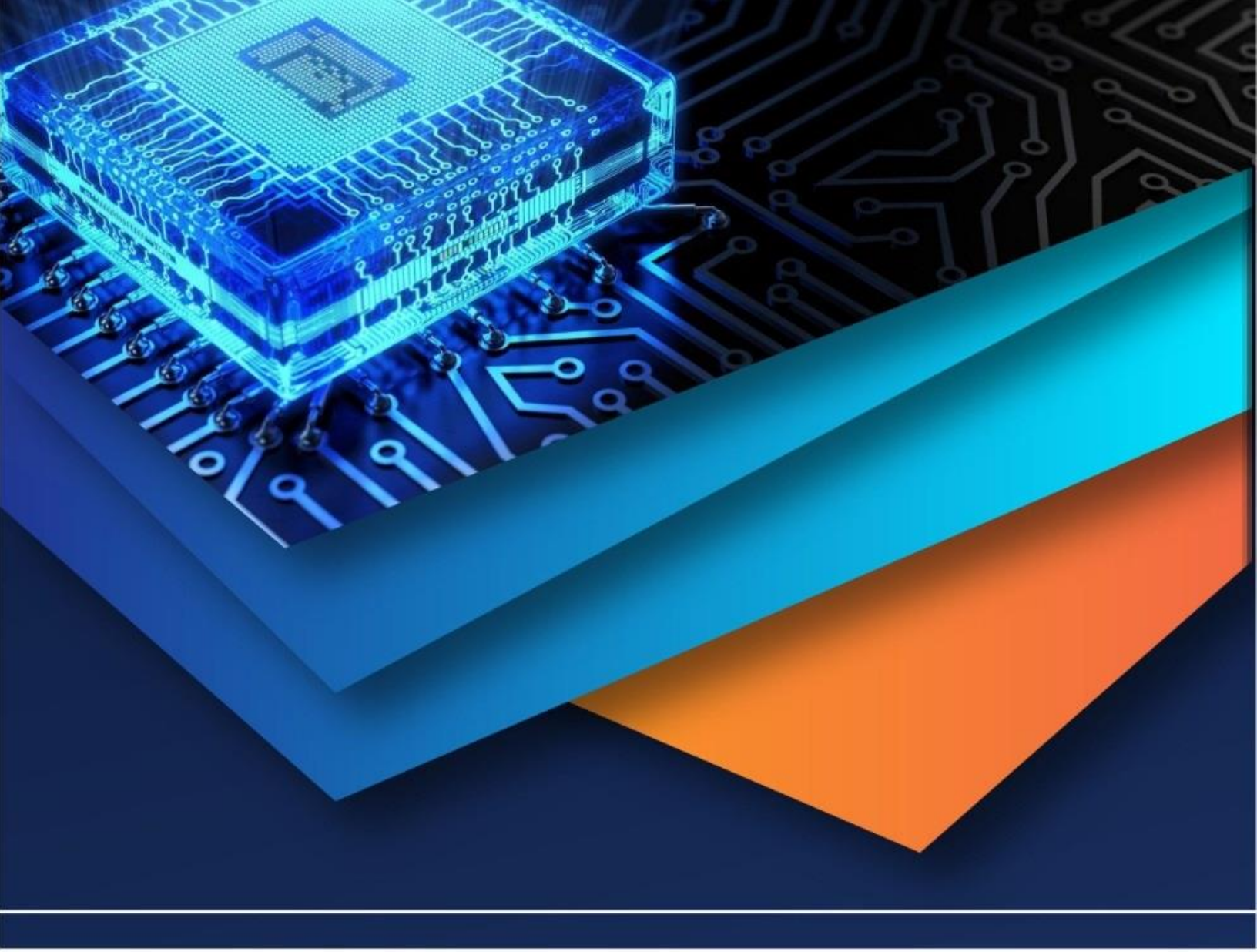

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