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Multi-Spindle Drilling Machine with Variable Centre Distance: A Review

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Abstract: *The challenge of today's world is to develop a new machining industries and company is mainly focused on the achieving of best quality, time saving operation, offer more flexibility As, the variety of products are increases day by day, industries are facing problem regarding the setup time which industry have to invest to produce different products. It leads to the decrement in the rate of production which eventually lead to disability of industry to meet the customer demand and eventually reduction in profit. Therefore, in today's modern era companies require the special purpose machines which can handle the production of different products and increase the production rate, increase flexibility which tends to give increment in production, Since, multi spindle drilling machine itself is a special purpose machine, therefore to improve the flexibility of machine different types of attachment can be used. We are going to use rack and pinion gear mechanism in conventional multi spindle drilling machine for offering the variable distance or we can adjust the distance between two spindles of multi spindle drilling machine for increasing flexibility and set up time.*

Keywords: *Multi spindle drilling machine, Rack and Pinion gear, Vary the distance between two spindles, Flexibility, Performance, Reduction in setup time.*

I. INTRODUCTION

The MULTI SPINDLE DRILLING MACHINE is one which can be used to drill a number of holes at various large and even unsymmetrical layouts according to our requirements, As the variety of products are increases day by day, industries are facing problem regarding the setup time which industry have to invest to produce different products. It leads to the decrement in the rate of production which eventually lead to disability of industry to meet the customer demand and eventually reduction in profit. Therefore, in today's modern era companies require the special purpose machines which can handle the production of different products and increase the production rate, offer more flexibility, reduce setup time. So, development of multi spindle drilling machine is necessary so it will give flexibility as well as variable distance, in such a way that it offers desire linear distance or variable center distance between two respective spindles with the help of rack and pinion gear mechanism.

A. *Different methods to vary the distance between two spindles are,*

- 1) We can use the idler gears in order to meet the requirement of variation in the distance.
- 2) Also, with the help of rack and pinion arrangement we can easily vary the distance between the two spindles.
- 3) Another method to vary the distance is the provision of toggle jack.
- 4) However, all of the above, mentioned methods are not feasible since some of these methods have various disadvantages which are listed below.
- 5) Use of idler gear increase the complication in the design of whole mechanism and also occupy the more space. Also, use of the toggle jack will improve the overall cost of machine and also make the mechanism fragile.

Therefore, the only possible solution which can be implemented at low cost and with lower efforts is to make a provision on rack and pinion arrangement which will help to improve the overall flexibility of machine.

B. *Useful Mechanism for This Project*

- 1) As initial research says that the major problem which industries are facing with the multi spindle drilling machine is the flexibility, as multi spindle drilling machine is not preferable the production of variety of products.
- 2) That's why the ultimate aim of project is the somehow develop the mechanism which can improve the overall flexibility of multi spindle drilling machine

C. Our Solution

For the improvement in flexibility of multi spindle drilling machine, the main objective is to vary the distance without affecting the power transmission. That's why for the flexible power transmission system belt drive is used instead of conventional spur gear setup. Also, for the variation in linear distance rack and pinion arrangement is used. Also, there is special provision of pair of worm gear which will not allow the motion of spindle while transmitting the power.

D. Our design for power transmission in Fusion 360

Firstly, we done experiment on three pulleys on fusion 360, then working on our project we find problem regarding tightness of belt and slippage of belt so, we modify it and add some pulleys for maintaining the transmission between pulleys. In actual prototype that, we made have six similar size timing pulley and two small size rubber pulleys for support.

For power transmission we used two timing belts, and motor having load capacity of 12kg, for vary the distance between two spindle we used rack and pinion mechanism which is our overall experiment and aim.

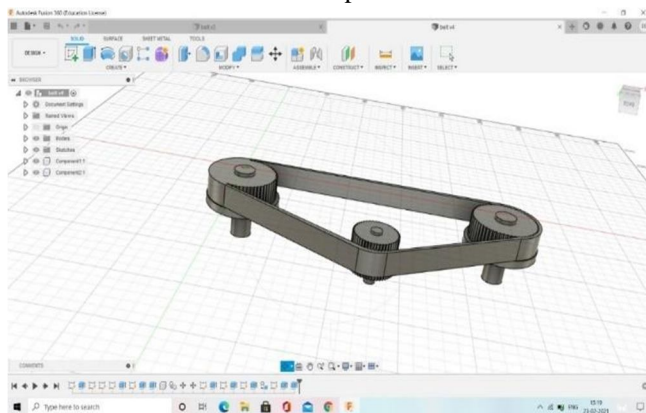


Fig. 1 Design on fusion 360 for power transmission

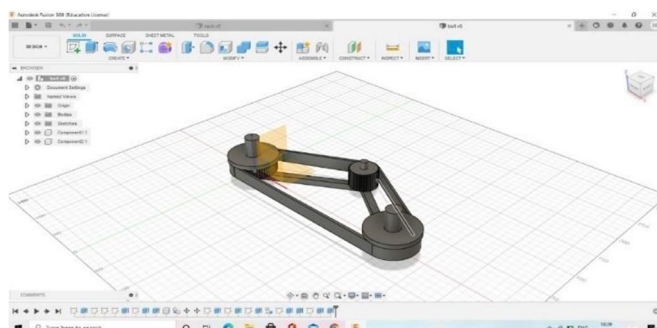


Fig. 2 Design on fusion 360 for power transmission (side view)

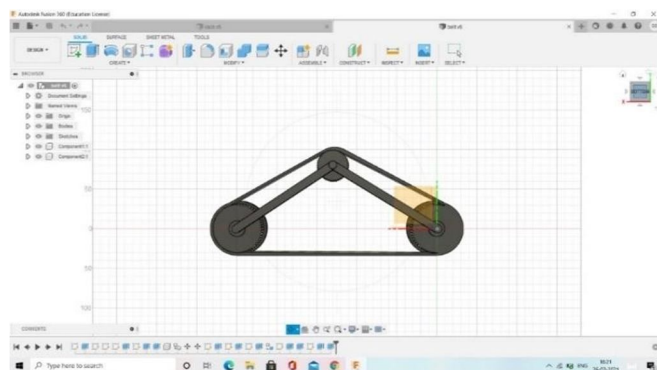


Fig. 3 Design on fusion 360 for power transmission (top view)

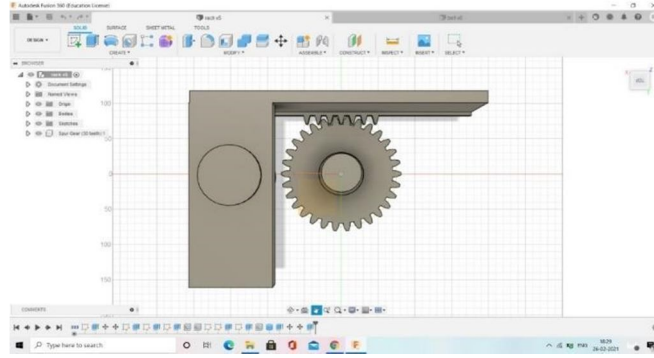


Fig. 4 Design on fusion 360 for vary the distance by rack & Pinion gear (top view)

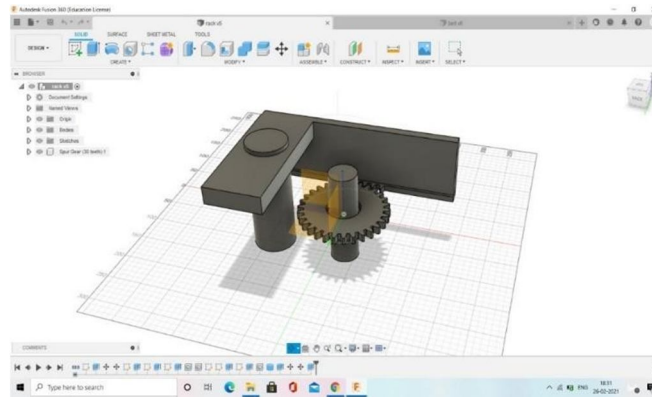


Fig. 5 Design on fusion 360 for vary the distance by rack & Pinion gear (section view)

E. Development of Multi Spindle Drilling Machine

The various types of component used in these machine-like gear, lower and upper body, bearing, shaft and keys, drill tool and chuck, rack & pinion gear, worm wheel, lead screw, motor. Information about multi spindle drill parameter and previous drilling machine.



Fig. 6 Actual Prototype

II. DIMENSION AND CALCULATION

Components	Dimension
Timing belt	Small-178XL, Large-490XL
Timing pulley	Dia.-5cm
Rack and pinion	-
Motor	12kg load
Drill bit	10mm
Drill chuck	1.5-10mm
Supporting pulley	Small, Large
Main frame with steel rod	-
Lead screw	-

A. Calculation for Tension on Belt

Velocity of belt:-

$$\begin{aligned}
 V &= 3.14 * d * N / 60000 \\
 &= 3.14 * 0.06 * 300 / 60000 \\
 &= 0.09 \text{ cm/s}
 \end{aligned}$$

Where N = r.p.m of motor

□ Center distance between two pulley C= 16cm □ Length of belt:

$$\begin{aligned}
 L &= 2C + 3.14 (D+d)/2 \\
 &= 2 * 16 + 3.14 (6) \\
 &= 32 + 18.84 \\
 &= 50 \text{ cm}
 \end{aligned}$$

Where L = Belt length in cm

C = Center distance between two pulley

D= d = Diameter of pulley

□ Tension in belt

$$\begin{aligned}
 T1/T2 &= e^{u(\theta)} \\
 &= 3.85 \text{ rad } u = 0.35
 \end{aligned}$$

$$T1/T2 = 2.71$$

$$T1 = 2.71 T2$$

Where , T1 = Tension in tight side

T2 = Tension in slack side

u = Coefficient of friction

- Also power p = (T1-T2)

- Power = 2 * 3.14 * 300 * 12 / 60

$$= 377 \text{ w}$$

$$377 = (T1-T2) * 0.09$$

$$T1-T2 = 4189$$

Also, T1 = 2.71T2

$$\underline{T2 = 2450 \text{ N, } T1 = 6639 \text{ N}}$$

III. CONCLUSION

With the help of this process parameter, we can drill three holes at a time with previous of increasing centre distance between two drilling spindles.

- A. The size of machine is minimizing than the previous machine so it is very easy to move any direction from one place to another.
- B. We can vary the distance easily with the help of rack and pinion mechanism with handle during the operation easily.
- C. Reduction in production time.
- D. Also reduce the setup time.
- E. Ease in operation, hassle free operation with less effort.
- F. With the help of lead-screw we also give up and down movement to the table.
- G. With the help of measuring scale, we can easily measure the distance and take measurement accordingly, during operation.
- H. So, from this we eventually increase flexibility, and reduce the production time and that is what we are trying to achieve.

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