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Design and Fabrication of Automatic Four-way Hacksaw Machine

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Abstract - In this paper, the design of an automated Four Way Hack-saw Machine which uses Motor, Linkages, Saw mechanism, Steel plates, etc. is presented. In small scale industries, the raw materials such as PVC pipes, wooden blocks, metal pieces need to cut into pieces for various applications. For such work, hack saw blade is used to cut the work-piece into desired pieces. In most industries this work is done manually by labors. This results in decreasing the efficiency of the industry as labors are not able to work all day in any industry. In some industries, hacksaw machines are used for cutting. But the biggest drawback of those machines is that only one work piece can be cut at a time on a single machine. This reduces the load on labors but is not so efficient as only one work-piece can be cut at a time. To deal with this problem we have designed a four way hack-saw machine. This machine consists of four hack-saw blades mounted in four directions. At a time four work-pieces can be mounted on the machine. We have used a AC motor for rotating the Cam which is linked with the Connecting Rods. The motor rotates the linkages on which the hack-saw is mounted. This mechanism helps in reducing time of cutting the work-piece and also gives a better efficiency and provides safety to workers.

Key Words: AC motor, Cam, Connecting rods, Double slider crank, Efficiency, Linkages.

1.INTRODUCTION

There are several industrial applications where large wooden lumbar and planks are operated on different machines to make furniture components like table tops, chair legs, back rests etc. This creates a need for mass production of these components. A Four-way hacksaw blade machine is a cutting device, with ability to cut four work-pieces simultaneously. A hacksaw is a fine–toothed saw-blade which is used to cut metals, plastic, wood etc. This paper proposes the prototype model of four-way hacksaw machine which is able to cut four pieces of wood at a time with minimum vibrations. The prototype model makes use of rotatory motion converted to linear oscillatory motion using a double slider crank mechanism overcoming the limitations of conventional hacksaw machines which can cut single piece at time. It is able to cut wooden bars of different dimensions at the same time. This makes the machine helpful in wooden industries due its compatibility, reliability and efficiency. The operation of the unit is simplified to a few simple operations involving a motor and a double slider crank mechanism. There are numerous machines in engineering field, which are used to cut work pieces. We aim to introduce multiple cutting operation in conventional hacksaw machine. The main function of this hacksaw machine is to cut pieces of wood using the power of a single electric motor.

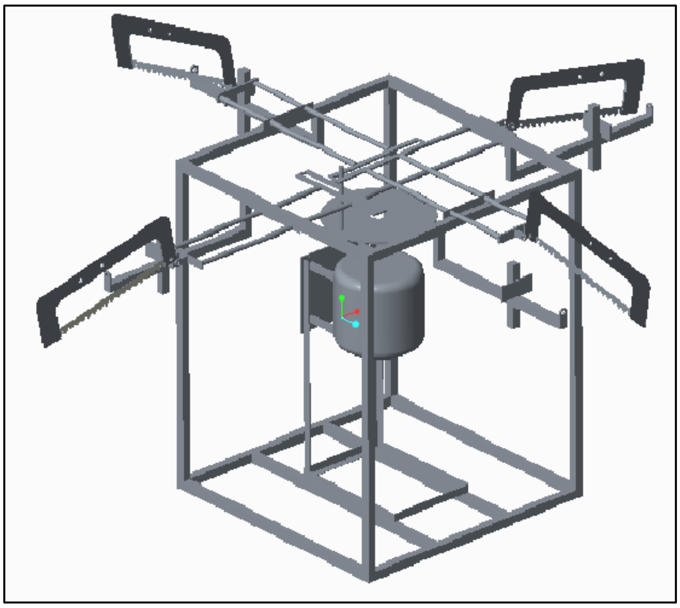

Figure 1- CAD model of Automatic Four Way Hacksaw Machine

2. OBJECTIVES

1) The main objective of the project is to reduce cost of cutting the wood.
2) To minimize human effort and save manpower.
3) Upgrading the existing technology.
4) To maximize production to power consumption ratio.
5) To make a safer wood cutting machine.
6) To prepare an efficient and cost effective system.

Sr. No.	Component	Material detail
1	Frame	MS
2	Four Hacksaw Blades	Bi-metallic
3	Four Guide-ways	MS
4	Disc	MS
5	Crank Pin	MS

6	Vices	MS
7	Connecting Rods	MS
8	Hacksaw Frames	MS

Table 1- List of components

3. METHODOLOGY

The single phase vertical electric motor rigidly placed at the center of the frame. The shaft of motor rotates at 90 rpm. The circular disc is mounted on the shaft of motor with the help of key and key slot arrangement. The eccentric point on the plane of disc is provided such that the desired cutting stroke is achieved (around 4-5 inches). One end of each connecting rod is pivoted at this eccentric point by the use of crank pin. The other end of every rod connects to the hacksaw blade frame with linear bushing getting vertical and horizontal degree of freedom of rotation for the proper cutting.
The hacksaw frame slides on the guide ways provided. When motor is turned on, the disc starts rotating and due to the reciprocating motion of hacksaw frame the metal rod is cut. The automatic feeding of coolant is provided to reduce heat generated due to friction which also reduces the jerk.

4. DESIGN CALCULATIONS

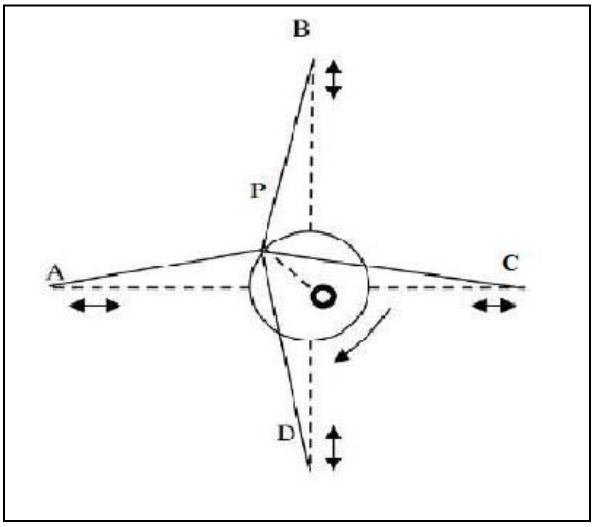

Figure 2- Top view of power hacksaw machine

The above figure shows a representation of the mechanism where OP is crank link and AP, BP, CP, DP are connecting rod links.
Rotary motion of the disc leads to reciprocatimg motion of the other links.

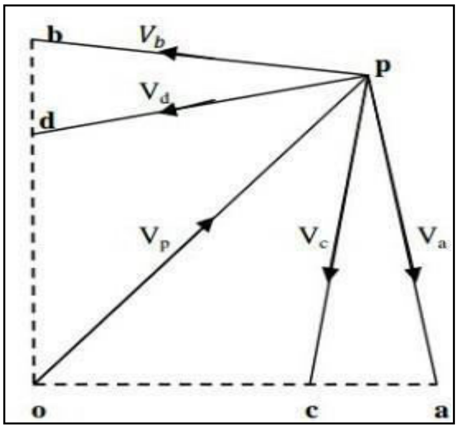

Figure 3- Velocity Diagram (Scale 0.588m/sec=50mm)

In the given velocity diagram, V_p is velocity of crank and V_a, V_b, V_c, V_d are connecting rod velocities.

5.1 Cutting force
For wooden block of dimensions 50.8 mm x 38.1 mm x L mm, A block of dimensions 50.8 mm×38.1 mm has been taken and the stroke length is 0.3 mm/stroke.
From, Properties of wood (Encyclopedia of Materials: Science and Technology, ISBN:0-08-0431526,pp. 9732-9736)
For teak wood, we take τ_{shear}= 8.8 MPa
Depth of Cut (d) = 0.3 mm/ stroke
Cutting Force Required (F) = τ_{shear} x CS area of cut= 8.8 x 0.3 x 50.8 = 134.112 N

5.2 Torque Calculation
From Velocity Diagram,
Considering Cutting stroke 5 inches =125mm
(Value taken by referring hacksaw manufacturer's catalogue)
As we know l is equal to 2r; where r =radius of the crank
Therefore r =62.5mm
The length of connecting rod = 450mm
Speed = 90 rpm (As per catalogue)
So angular velocity ω =9.424 rad/sec
Here OP = crank radius
OA=OB=OC=OD= connecting rods
ω_{po}= 9.42rad/sec
Since op= 0.0625m
So velocity of p wrt o
$V_{po} = V_p = 9.42 \times 0.0625 = 0.588$ m/sec
From velocity diagram, we get velocities of slider
V_{ap} = 4.4 cm/sec = 0.44 m/sec
V_{bp} = 4.1 cm/sec = 0.41 m/sec
V_{cp} = 4.4 cm/sec = 0.44 m/sec
V_{dp} = 4.1 cm/sec = 0.41 m/sec
Required Torque
We know forces at A,B,C,D
$F_A=F_B=F_C=F_D$= 134.112
Power input = $T_o \times \omega_{po} = T_o \times 9.42$ Nm/sec
Power output = $(F_a \times V_a) + (F_b \times V_b) + (F_c \times V_c)$

+ (F_d ×V_d) = (134.112 × 0.44) + (134.112 × 0.41) +(134.112 × 0.44)+ (134.112 × 0.41) =228 Nm/sec
Neglecting losses, we assume power input is equal to power output
We get,
T_o × 9.42 = 228 Nm/sec
T_o = 24.2 Nm.
Available Torque
P =2πNT/60
Where N =90 rpm
P = 100 watt=2πNT/60
6000=180*π*T
T =573.24 Nm.

5.3 Motor Power-
P = $(F\times V)_A + (F\times V)_B + (F\times V)_C + (F\times V)_D$
P=228 Nm/sec=0.305 hp
Thus , a motor with 0.5 hp power and 24.2Nm torque is required with 90 rpm speed.

5. FABRICATION CHALLENGES

Sr.	Operations	Challenges
1.	Calculation of cutting speed and force	Assumptions and standard values
2.	Motor Selection	Based on Cutting force of 4 blades
3.	Selection of motor with required torque	Torque sufficient but need to lower the speed
4.	Procuring a dimmer circuit to regulate RPM	High rpm to calculated(assumed) rpm
5.	Construction of frame	Establishing required vertical distance between the disc and reciprocating member
6.	Assembly of Motor	Making an arrangement to withstand the weight of the motor
7.	Assembly of reciprocating member	To restrict degree of freedom of the member
8.	Assembly of Connecting rods of equal lengths	Proper Pin joints should be used.
9.	Assembly of hacksaw and vice	The stroke length should be sufficient to cut the specimen on the vice. Vertical Force application can be done using compression spring

Table 2- Fabrication challenges

6. DISCUSSION

The maximum size of Round or Square bar to be cut can be increased by increasing the motor power and dimensions of different parts. Automatic lifting up mechanism for frame when cutting operation is finished to introduce next portion of bar for cutting can be introduced. Large diameter pieces can be cut as the hacksaw frame size can be changed unlike other hacksaw machines. Independent side working can be achieved by introducing a lock-key mechanism. Vertical force can be applied to the frames by spring action if the material to be cut is hard.

7. CONCLUSION

Thus a low cost and simple design four-way hacksaw blade machine reduces the power and effort in wood cutting operations. The time required is reduced and the machine certainly provides a much safer equipment for the operators to work with. This simple design which can enhance the current power hacksaw machines will certainly aid in improving efficiency and increase production rate. It not only has applications in wood cutting industry but can also be used in metal cutting operations.

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BIOGRAPHY

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