MANUFACTURING AND ANALYSIS OF FOUR-WAY HACKSAW MACHINE BY PEDALING

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ABSTRACT

A modernized four way hacksaw machine and less stress full operation for cutting wood, metal, and plastic materials without any electrical energy. The aim of this work is to develop a hacksaw machine that will use a less effort to produce uniform cutting of PVC pipes, metals, wood. It is also done to show the performance difference between the hand driven, pedal drive and four-way hacksaw machine. This model implies a conversion of rotary motion of crank to the reciprocating motion of hacksaw blades, which is done by using the Scotch Yoke Mechanism.

KEYWORDS: Hacksaw, Pedaling, Scotch Yoke, Slider Crank & Chain Drive

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INTRODUCTION

The main objective of our project is to design a portable robust machine which can perform multiple machining operations like cutting simultaneously using pedal power with less human effort, without using electric power. And also this work is to design a machine to overcome the stress attached to hand cutting, operations of engineering materials by turning it into an exercise for body fitness. When pedaling the conversion of To and Fro motion about the hacksaw by the rotation of the wheel. In that, the size and shape are same as to a by cycle. This equipment can be run by a very low energy. The Machine works with pedal power. The input rotatory motion is integrated using chain drives and sprockets to get high angular velocity.

WORKING

A multiple machining setups which are run by the pedal has a simple operating mechanism it means the arrangement of chain and sprocket gear. When pedaling the conversion of To and Fro motion about the hacksaw by the rotation of the wheel. Such type of process is called a slider crank mechanism.

The Machine works with pedal power. The input rotatory motion is integrated using chain drives and sprockets to get high angular velocity.

The hacksaw getting a To and Fro motion by the pedaling, then the disc is rotating. The pipe vice is fixed at the end to hold the workpiece tightly in a straight position. When applying human energy on to the pedal, then the chain rotates it means it is connected to two sprockets which give the movement to hacksaw blade. The movement of the blade cut the workpiece which is placed on the work holder.

Figure 1: Layout of Prototype Model of Four Way Hacksaw Blade Machine

METHODOLOGY

Figure 2

WORKING PRINCIPLE

The conversion of circular motion into reciprocating motion is a simple operating mechanism, also called as Scotch yoke mechanism. The power is supplied to the DC motor, shaft, and crank attached to shaft start rotating. As the crank rotates the pin slides inside the yoke and also moves the yoke forward. In the forward direction of initial position, the yoke will get a displacement by the rotation of crank in a clockwise direction. The completion of crank rotation the moving yoke, its length is doubled to the crank length. The yoke moves in the backward direction in third rotation of the crank.

Figure 3: Scotch Yoke Mechanism

Advantages & Disadvantages of Scotch Yoke Mechanism

Advantages of scotch yoke mechanism are,

High torque output with a small cylinder size.

- Fewer moving parts.
- Smoother operation.
- A higher percentage of the time spent at top dead center (dwell) improving engine efficiency.
- In an engine application, elimination of joint typically served by a wrist pin, and near elimination of piston skirt and cylinder scuffing, as side loading of the piston due to the sine of connecting rod angle, is eliminated.

The Disadvantages are

- Rapid wear of the slot in the yoke caused by sliding friction and high contact pressures.
- To reduce the blow down time in 2 stroke engines when spent the Lesser percentage of the time at bottom dead center.

DESIGN & FABRICATION

First, we designed the idea of machine structure, base, alignment of the three operations using Autodesk inventor professional. Since the machine should bear a human weight and have to sustain huge vibrations due to the operations drilling and grinding, we have designed a robust and strong base for the machine. We arranged the three operations in three directions at perpendicular angles. One main base frame is provided with the pedal, two chain drives, and three sprockets. The main base frame is designed such that it resembles a bicycle frame. It gives the bicycle feel while pedaling as the dimensions are taken from an actual cycle. The design of this machine has two components. They are Pedaling Equipment and Cutting Equipment.

Figure 4: Fully Fabricated Machine

FABRICATION

We fabricated the machine with four operations of cutting. Everything in the fabrication was done in an ordinary workshop. We used electric arc welding in fabricating the machine with tungsten as the electrode.

We used cast iron frames to fabricate the base design. In order to increase the angular velocity, we have used two chain drives. The specifications of sprockets are as follows

- **Sprocket I:** Diameter 18 cm, Teeth 44
- **Sprocket II:** Diameter 8 cm, Teeth 17

Total Obtained Gear Ratio by two chain drives = 2.25

i.e. for one revolution of pedal, we are getting 2.5 revolutions. If we can consider 60 revolutions per minute as the maximum capacity of a human, we can easily get 150 revolutions per minute.

The Cutting Equipment is arranged to the four sides of the output shaft. The Cutting Equipment is connected to the output shaft using Bevel gears which are aligned at a right angle. The power from the output shaft is transferred to another shaft to which a disc is attached using bevel gears.

DESIGN ANALYSIS

Design Data

Human energy expended say 70Kg (150 lb) person

For cycling @ 15Km/hr. (16-24Km/h) = 1.62KJ/Kg

The average cycling speed = 15.5km/h

The cycling speed in r. p. m = 120 rpm.

Design Calculations

So, using the weight of an average man say 60-75kg,

1kg mass of flywheel but flywheel radius = $D/2 \times 100$ meters

$$= 3102 \times 100 \text{ m}$$

$$= 155 \text{ mm}$$

$$V = 25.14 \times 0.15 = 3.89 \text{ M/S}$$

$$\begin{aligned} FC = m r \omega^2 &= 15 \times 0.155 \times 25.142 \\ &= 1469.45 \text{ N} \end{aligned}$$

$$\text{The power, } P = FC \times V$$

$$= 1469.45 \times 3.89$$

$$= 5716.14 \text{ W}$$

$$\text{The Torque } T = FC \times V$$

$$= 1469.45 \times 0.155$$

$$= 227.76 \text{ Nm}$$

Velocity Ratio

$$V.R = \text{effort distance}$$

length of crank pedal load distance hacksaw cutting stroke

$$100 \text{ mm} = 100 = 0.65 \text{ radius of flywheel.}$$

$$V.R = 0.65 \text{ which is less than 1.}$$

Efficiency of the Machine

$$\text{Efficiency} = M.A$$

$$= IMA \times 100\% \text{ V.R}$$

$$\text{Where I.M.A} = \text{Ideal Mechanical Advantage} = 0.5 \text{ (as calculate earlier). Efficiency} = 0.5 \times 100\% \times 0.65 = 76.9\%$$

RESULTS AND DISCUSSIONS

The machine cutting strength tested on different materials like PVC pipes, wooden bars, and metal pieces. Ideally, the mechanical advantage is 0.5, the output energy is 5.72KW and its efficiency is 76.9%, it is also used for exercise as well as to cut the work piece as compared to the old machines.

CONCLUSIONS

At the end of the design, construction, and testing, a satisfactory pedal powered four-way hacksaw machine having Ideal Mechanical Advantage of 0.4 and a power output of Range of 2KW to 5KW (depending upon the pedaling speed) was fabricated using available raw materials and techniques. The efficiency of the machine was confirmed by observing the overall performance like PVC pipes, metal pieces, wooden bars were successfully machined.

If the industries are taking this type of machines, due to their performance maintenance and production cost is very cheap. Thus the pedal operated four-way hacksaw machine is designed tested successfully. BY the action of pedaling, the tool output is verified.

Since the links connected between the hacksaws and bearing ring are flexible which means they can be loosened when needed. Four or three or two or even one hacksaws can be operated depending upon the cutting operator requirement. The project is designed and constructed for small-scale industrial and homemade applications of various machining operations.

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