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Design and Development of Pedal Operated Hacksaw Machine

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Abstract- The pedal powered hacksaw has a very simple mechanism operated with pedal by pedaling the wheel rotary motion is converted into to and fro motion of the cutting tool. The aim of this paper is to cut materials like wood, plastic etc., with less effort and quickly. That is by connecting a hacksaw to the pedal of a cycle and pedaling the pedals the forces are transmitted and get the work done. The size and shape of the pedal power hacksaw setup is similar to the cycle. It is like a cycle added with a bed for the cutting tool. It can be used in the place where electricity is not available. As it required very low pedaling power it is operated at very low power. In this pedal powered hacksaw connected directly to the pedal .While pedaling directly rotary motion of the pedal is converted into to and fro motion of the cutting tool. The end of the cutting tool is placed on the workpiece. By the to and fro motion of the cutting tool action is done on the work piece .In this way by applying force on the pedal of the cycle the cutting tool undergoes to and fro motion and we get the required work done.

Keywords:- Pedal hacksaw cutting tool motion etc.

I. INTRODUCTION

Hacksaws were originally and principally made for cutting metal, but can also cut various other materials like plastic and wood. Hacksaw blades are normally quite brittle, so care needs to be taken to prevent brittle fracture of the blade. Early blades were of carbon steel, now termed 'low alloy' blades, and were relatively soft and flexible. They avoided breakage, but also wore out rapidly. Except where cost is a particular concern, this type is now obsolete. 'Low alloy' blades are still the only type available for the junior hacksaw, which limits the usefulness of this otherwise popular saw.

Power hacksaws are used to cut large sizes (sections) of metals such as steel. Cutting diameters of more than 10/15mm is very hard work with a normal hand held hacksaw. Therefore power hacksaws have been developed to carry out the difficult and time consuming work. The heavy 'arm' moves backwards and forwards, cutting on the backwards stroke.

Power hacksaws have electric motors that power the blade through a pulley system. Some have ratchet systems. The pulley system shown below shows

1. Applications:

- It is mainly used to cut steel and other metals such as bars or pipes or rods into the desired length.
- It also can be used to cut plastics.
- It can also cut wood, but it is not normally used to cut woods.
- It is generally used for cutting and sawing, it is mainly suitable for cutting hard materials like stainless steel and alloy
- A hacksaw is better for cutting thinner materials. Cutting thick materials may become difficult and may damage or break the blade of the saw.
- They are mainly used for household work purpose and industry work purpose.
- Hacksaws are often used by plumbers and electrician for cutting plastic pipes and plastic conduit.

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2. Hacksaw Blades:

2.1 Course Grade Hacksaw Blade: Hacksaw blade of this grade is used for cutting thickness of mild steel, copper, aluminum and brass etc. It contains 14 to 18 teeth per inch.

2.2 Medium Grade Hacksaw Blade: Hacksaw blade of this type is used for cutting all kinds of metals such as cast iron, tool steel, aluminum, brass, high carbon steel etc. From 20 to 24 teeth per inch are cut in this hacksaw blade.

2.3 Fine Grade Hacksaw Blade: This type of hacksaw blade is mainly used to cut thin pipes, sheets, tubes etc. It has 24 to 30 cents per inch.

2.4 Flexible Blade: In blades of this nature only the cutting teeth and nearby part it hardened and tempered. But this process they become elastic and there is less risk of their being broken in the event of a shock. These blades are used for cutting thin sheets, pipes, curves etc.

II. PROBLEM DEFINITION

1. Problem Statements:

- A major disadvantage of power hacksawing machines is that they are slower than other sawing machines.
- It Requires Electric Power source so it can be installed only where the supply of electrical energy is available.
- It is heavier in construction and cost.
- For low cutting operations, the machine cost and construction is too high with various maintenance charges.

The Power Hacksaw machines are not suitable for workpiece of small scale production or the areas where the electric supply is not reachable like agricultural areas.

Hence for the same the alternative hacksaw machine is required which generally operates without the source of electric energy or other dependent source of energy.

2. Project Objectives:

This project concentrates on pedal powered hacksaw machining. An individual can generate four times more power (1/4 HP) by pedalling than by hand-cranking. Pedal power is the transfer of energy from a human source through the use of a foot pedal and crank system. Hence in this case, the pedal operated hack saw is been designed and developed.

- To analyse the press force required for cutting operation.
- To analyse the speed and length of cutting stroke.
- To determine the mathematical design of chain and sprocket mechanism.
- To determine the mathematical design of crank and slider mechanism
- To design the blade for low force cutting application in order to prove the problem statement.

III. MATHEMATICAL MODELLING

1. Working Mechanism:

- It consists of the pedal arrangement which rotates the crank and through it slider consists of oscillating mechanism.
- The power is transmitted to the crank and slider mechanism.
- This mechanism is used to rotate the crank disc; the disc which is having an extended rod is connected to the sliding portion of the hacksaw directly by means of a linkage.
- The hacksaw is passed through the guide ways by means of maintaining the cutting axis.
- As the user operated the pedal, the hack saw cuts the various materials automatically with less power.
- The dead weight is for compressive force while the user operated the foot pedal.

This mechanism consists of a larger sprocket which rotates with a help of human powered pedal. The smaller sprocket is connected to the plane which is mutually perpendicular to the axis of the larger sprocket is made rotated by using chain drive. The smaller sprocket is rigidly supported by means of shaft and bearing support. The circular saw is mounted on the same shaft where the smaller sprocket is mounted. When the pedal is operated, circular saw rotated which in turn cuts the material.

The rule of pedal power hacksaw is to convert the rotating motion of the paddle into reciprocating motion and cut materials such as metals and plastics with the assistance of a metal cutting bar.

It is a pedal worked framework. Appropriate cutting edge choice is critical. The Major two Mechanism of Hack Saw is Sprocket Mechanism and Slider Crank Mechanism

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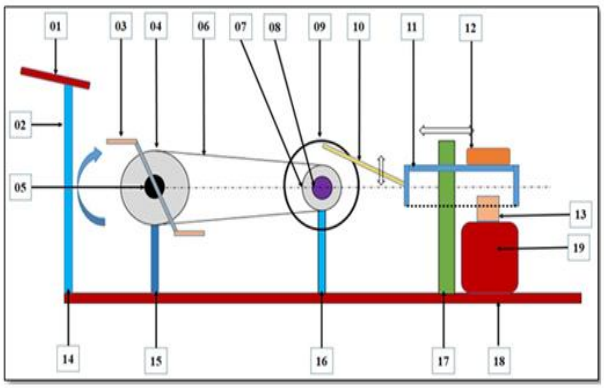

Fig 1. Block Diagram of Pedal Powered Hacksaw Mechanism. Discription

1.	Seat	11	Blade Hacksaw
2.	Seat Stand	12	Dead Weight
3.	Pedal Bar	13	Workpiece
4.	Large Sprocket	14	Seat Stand Frame
5.	Large Sprocket Shaft	15	Large Sprocket Frame
6.	Chain Drive	16	Small Sprocket Frame
7.	Small Sprocket	17	Blade Hacksaw Frame
8.	Small Sprocket Shaft	18	Base Frame
9.	Crank Wheel	19	Fixture of Workpiece
10.	Connecting Rod		

IV. MATHEMATICAL DESIGN

Considering the speed of the Hacksaw in terms of Strokes, as

N3 = 60 Strokes/Minute = 1 stroke/Sec

Hence the Linear velocity of the Hacksaw,

VS = [S/ N3]/2 = 100 mm/sec

VS = 0.1 m/s

The Stroke Length is S = 200 mm,

Consider,

- R = the crank length in mm
- R = S/2
- R = 100 mm

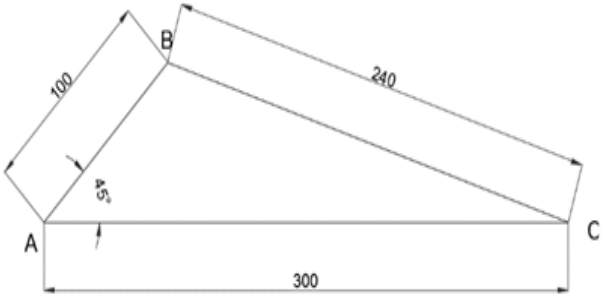

Fig 2. Graphical Method for Connecting Rod Length.

The Length of Connecting rod using the graphical method can be determined,

LC = 240mm

If, ώ = Angular Speed of the crank,

Hence the analytical method of Slider can be given as,

VS = ώ x R x {Sin Θ + [Sin2Θ/2n]}

ώ = 1.1 Rad/Sec

Hence the angular Velocity of the Crank is 1.1 Rad/Sec

ώ = [π x d x N]/60

Where d = Diameter of Crank = 200 mm = 0.2m

1.1 = [π x 0.2 x N]/60

The Speed of the Crank, N =106 RPM.

A human can maximum run the bicycle at the speed of 80 Rpm, Hence,

N1 = Initial speed of Driving Sprocket = 80 RPM

The Diameter of Driving Sprocket (D1) = 200 mm = 0.2 m

As the crank and driven sprocket are couple in the same shaft,

Speed of Crank (N) = Speed of Sprocket (N2)

Hence the Speed of Sprocket (N2) = 106 RPM.

The Speed ration states that,

N1 D1 = N2 D2

Rearranging the Above equation,

[N1 D1]/ N2 = D2

[80 x 0.2]/106 = D2

D2 = 0.15m

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Hence the diameter of Driven Sprocket, D2 = 0.15m or150mm
Considering the material of shaft as Mild Steel with Shearing Strength as 200 MPa

Hence,

$$T = [\pi/16] \times \tau \times d3$$
$$73500 = = [\pi/16] \times 200 \times d3$$
$$d3 = 1871.66$$
$$d = 12.32 \text{ mm [Safe Diameter for shafts]}$$

The safe diameter of shaft is been designed as12.32 mm. Hence considering the availability the shaft of driven and driven sprocket be considered as 15 mm in order to ensure more safety.

V. COMPUTER AIDED DESIGN

Fig 3. Chain Sprocket Mechanism.

The Function of chain drive is to convert the pedal operated manual force to rotary motion of sprocket, thereby rotating the crank wheel. The other function is to speed up the human force with respect to the driven sprocket so as to maintain the speed stroke of hacksaw.

Fig 4. Bicycle Pedal.

A bicycle pedal is the part of a bicycle that the rider pushes with their foot to propel the bicycle. It provides the connection between the cyclists' foot or shoe and the crank allowing the leg to turn the bottom bracket spindle and propel the bicycle's wheels. The Size of the pedal is 60mm by 70mm and thickness is 10mm. The size of pedal crank is 250mm in length with the bearing housing provided of 30mm in diameter and internal hole for the driving shaft as 15. The parts will be selected standard.

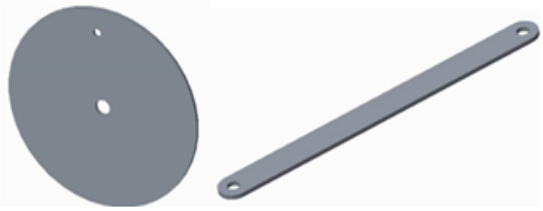

Fig 5. Crank Connecting Rod.

The Crank wheel is connected to the driven shaft of the small sprocket. The speed of small sprocket and crank are same. The Crank will be made of Mild Steel with the diameter as 200mm and the thickness is 3mm. The hole is provided to pivot the rivet with connecting rod.

The width of connecting rod is 20mm with the length as 240mm and the thickness is 3mm. Two holes are provided of 8mm diameter to the pivot the rivet one for crank and other for hacksaw. The material of connecting rod will be Mild Steel.

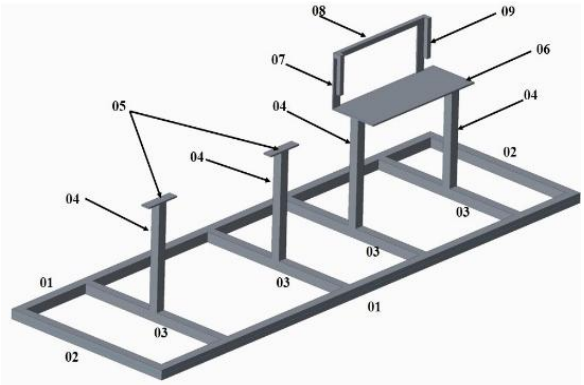

Fig 6. Frame.

Table 1. Components of Frame.

No.	Part Name	Quantity
1	Base Square Pipe - 1	02
2	Base Square Pipe – 2	02
3	Middle Square Pipe	04
4	Support Stand	03
5	Bearing Plates	02
6	Fixture Plate	01
7	Guide Plate	02
8	Guide Rod-1	01
9	Guide Rod-2	02

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VI. ASSEMBLY OF PEDAL POWERED HACKSAW MECHANISM

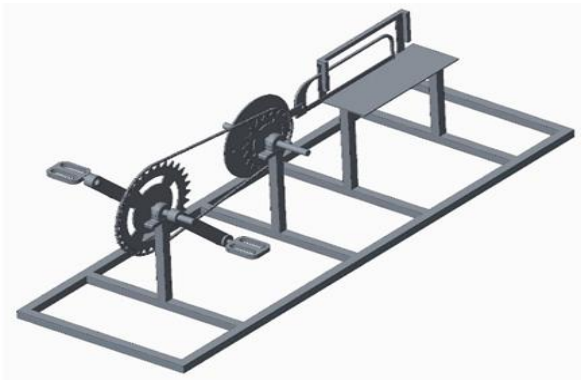

Fig 7. Assembled View of Hacksaw Mechanism.

VII. CONCLUSIONS

The machine is cost effective compared to power hacksaw machine. Also, the machine consumes no electricity at all, which is a major plus point. Machine is simple in design, reliable, and can be used where electric supply is not available, particularly in rural areas. The machine operates with the mechanical efficiency of 78.94% and mechanical advantage of 0.45. The only maintenance required is lubrication. Teeth blunt rate and wear rate is very slow. If maintained properly, the life of the machine is more than 10 years

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