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Design & Development of Four Way Hack Saw

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Abstract*: Cutting of material is one of the important machining parameters for development of different fabricated model like shaft, bolts and screws etc. for a mass production the material need to cut in a multiple way or manner at a same time and this is to be perform on a power hack saw or multiple way hack saw machine which consume less time. This paper propose the design considerations and development of four way hacksaw machine which is able to cut four pieces of same or different material simultaneously with a very less time consumption. The motor is used as a source of power generation. Conversion of rotary motion of motor shaft into reciprocating motion is obtained by using eccentric cam. This machine can perform cutting operation on four different components by four ways at a time on different material simultaneously and therefore this machine becomes very useful in industry because of its efficiency, reliability and compatibility. This machine overcomes traditional hack saw machine which cuts material single work piece at particular time interval and also fulfills today's need of mass production

***Index Terms*: Four ways hack saw, eccentric cam, Motor, Mass production**

I. INTRODUCTION

There are many electrically powered hacksaw machines of different configurations which are available for the use in machine shop. These machines can cut pieces of different material precisely at very fast rate but they can cut rods of one material at a time which means they can't able to cut dissimilar material at a same time. Now in industry, it is essential to cut metal bars with very high rate to achieve mass production requirements with in short time [3]. So it is essential to go for a new modern technology and design which gives us a mass production with less time and less energy input. It is quite impossible to depend upon conventional hacksaw machine. In this four way hacksaw machine the four metal bars or rods can be cut simultaneously to achieve high speed cutting rate and mass production for maximum benefit in manufacturing industries.[4]It can be used in a small workshops and industries as it is very economical and its smaller size and high efficiency. The setup of four ways hack saw machine is very simple in design and it operates with mechanism of eccentric cam disc arrangement. The disc is attached with motor, rotary motion of motor shaft wheel is converted into the reciprocating motion of the cutting tool hacksaw. [5]This reciprocating motion is used to obtain the linear motion of blades and material is cut into desire size. The size and shape of this setup is small. Bed along with vice is provided for placing the work piece to be cut. A low power motor is required for its operation. Length of crank and connecting rod is designed using proper requirement. Motion of hack saw is guided by guiding rods placed over the hack saw frame. The vertically downward motion is occurred due to self-weight of frame, so it can be called as gravity feed hack saw.

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II. LITERATURE REVIEW

O.Cakir et. al. (2007)[1] This research paper explain about the machining operation with high temperature in a cutting tool results due to friction between work piece and cutting tool and cutting tool chip interface. Some effects of this generated heat are higher surface roughness, shorter tool life and lower dimensional sensitiveness of the work material. This result is more important when there is need to machine harder material which is difficult to cut due to high heat production. There are different methods of protecting cutting tool from heat generation during machining operation. One of the alternative is to select the coated which is expensive an only suitable for machining of material like heat resistance alloy, titanium alloy etc. apply the cutting fluid on tool and work piece while machining is another approach, which can provide cooling effects and lubrication between cutting tool and work piece and chip during machining operation. Hence effect of generated heat on cutting tool and work piece can be eliminated fully or partially. Use of cutting fluid gives advantages like easy chip flow, longer tool life and highest machining quality in machining process. It is required to select the cutting fluid by considering various parameters so that to get optimum result in machining process. The parameters to be considered are as cutting tool material, work piece material and method of machining process. Nitin chandra R. Patel, et al. (2013)[2] This research paper explain about the Material selection and testing of hacksaw blade based on mechanical properties and stated that to obtain better operation, appropriate blade must be selected. To obtain fine cutting of work piece selection of teeth per inches of blade is very important. [7]There are four types of hack saw blades in the market which are based on the material classification namely alloy steel blade, high speed steel blade, and high carbon steel blade and bimetallic blades. On the basis of wear resistance cutting performance and properties of material bimetallic blade is best suitable blades for hack saw.

This study gives guidelines about selection of material for our model in present situation the hydraulically and electrically operated hack saw machines are available but these are require more input as compared to output i.e. it does not gives satisfactory output. Also it can be able to cut only one component at a time a machine cuts four rods at a time gives improved productivity. As PDH uses a slider crank mechanism but we are going to use eccentric cam for obtain reciprocating motion.

III. PRINCIPAL AND WORKING

This machine model consists of single phase vertical electric motor rigidly placed on the center of metallic foundation. The shaft of the motor is rotates with electric power. The circular disc is mounted on the shaft of motor with the help of key and key slot arrangement. [6]The eccentric point on the plane of the disc is drilled in such way that the desired cutting stroke is achieved. One end of each connecting rod is pivoted at this eccentric point by using suitable bearing and another end of each connecting rod is connected to hack saw blade frame with the help of universal joint to get vertical and horizontal degree of freedom of rotation for proper cutting operation. The hack saw frame slides on guide ways. When motor is switched ON, the disc is start rotating and due to reciprocating motion of hack saw frames the metal rod start cutting at desired point of location.

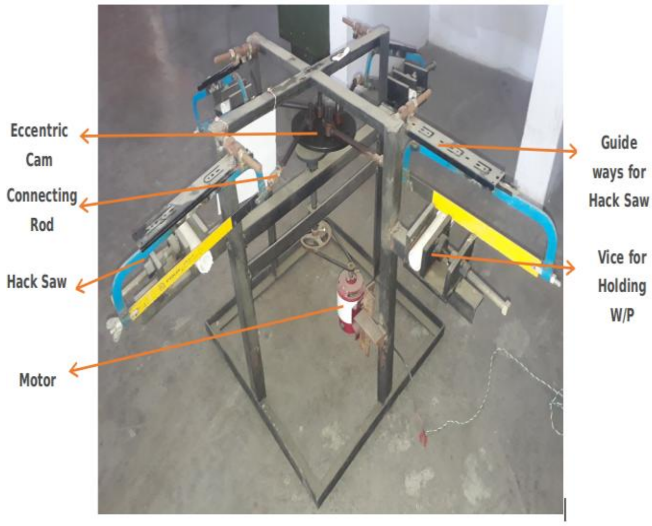

Fig 1: Four-way hack saw

IV. DESIGN PARAMETERS

The basic design process consists of various design parameters like application of scientific principles, technical information and imagination for development of new or improvised machine with maximum economy and efficiency. Hence it is necessary to adopt careful and safe design approach. The entire design of machine consist of two parts

1. System design
2. Mechanical Design.

1. System Design

System design mainly focus on various physical constraints and ergonomics like space requirements, arrangements of various components on main frame of machine, man +machine interactions, number of controls and its positions, safety measures, ease of maintenance, scope for improvement, total weight of machine and many more.

The detached design is done for designed parts and various distinctions obtained are then compared to next highest dimensions which are easily available in market.

This amplifies the way of simple assembly as well as post production servicing work of machine for easy maintenance.

The various tolerances on the works parts must be specified.

In system design we mainly focus on the following parameters

A. *System Selection Based on Physical Constraints*

Before selecting any machine it must be checked whether it is going to be installed and used in a small scale industry or large scale industry. This machine is to be used by small scale industry, so space is the major constraint for this machine. The system needs to be very compact so that it can be installed to the corner of room for its easy operations. The mechanical design has direct norms for the system design. Hence the major job is to control the various physical parameters, so that the number of distinctions obtained after mechanical design can be well fitted.

B. Arrangement of Various Components

The various components of machine should be laid in such that their easy removal or servicing is possible. Each and every component should be easily seen none should be hidden to the operator of machine. So due to the space constraint every possible space is utilized while doing component arrangements

C. *Components of System*

Components of system should be compact enough so that it can be easily assembled and set inside the machine. All the moving parts of machine should be well closed and compact.

D. Man machine Interaction

The machine should be very much friendly to the operator because operating is an important factor of design. Anatomical and psychological principles are used to solve various problems arising from Man + Machine relationships

Following are some of the topics which are related to Man +Machine relationship

E. Height of Machine from Ground

Height of the machine is very important design consideration for easy working and comfort of operator. The height of the machine should be properly decided so that operator may not get tired during operation. The machine should be slightly higher than the waist level of operator and also suitable clearance should be provided from ground level for cleaning purpose.

F. Weight of Machine

High weighted machine is not desirable because of transportation and breakdown problems. The entire weight of machine depends on selection of material for components and its dimensions. so it is very important to select components of lighter material available as per design specification.

2. Mechanical Design

Mechanical design is very important phase from design point of view because the whole success of project depends on the proper design analysis of problem. During this phase many preliminary alternatives are eliminated and designer should have adequate knowledge about the physical properties of material, deformation, failure, load stresses, various theories and wear analysis. Designer should be able to identify the various external and internal forces acting on machine parts
It is required to estimate these forces accurately by using proper design equations. Selection of factor of safety is very important step in design of working dimensions of machine elements. The required correction in theoretical stress values needs to be made depending upon kind of loads, shape of parts, and service requirements. Selection of various materials for machine should be made according to the condition of loading, shapes of products, environment conditions & desirable properties of material.

V. DESIGN CALCULATIONS

A. Input Shaft

Input Power = 50 Watts
Motor speed = 0-9000 rpm
Input shaft speed = 360 rpm
In designing four way hack saw machine we have considered a higher end motor of power 0.25 Hp (185 Watt) in order to incorporate the factor of safety.
$P = 2\prod NT/60$
$185 = 2\prod 360T/60$
T = 4900 N-mm

Table 1: Selection of material for Input shaft

Material Designation	Tensile strength N/mm^2	Yield strength N/mm^2
EN 36 (13 Ni3Cr80)	800	680

Maximum allowable shear stress is given by

$fs_{max} = 0.18\ S_{ut}$
$= 0.18 \times 800$
$= 144\ N/mm^2$
OR
$fs_{max} = 0.3\ S_{yt}$
$= 0.3 \times 680$
$= 204\ N/mm^2$
By Taking into consideration minimum of above values
$fs_{max} = 144\ N/mm^2$
$4900 = \prod\ 144\ d^3 / 16$
d = 5.15 mm
Assuming appropriate diameter
D = 12 mm
Therefore minimum section diameter of input shaft = 12 mm

B. Design of Crank Pin

We know that
T = Force x Radius
4900 = Force x 25
Force = 196 N
Assuming pin diameter = 10 mm

Table 2: Selection of Material for Crank Pin

Material Designation	Tensile Strength N/mm^2	Yield Strength N/mm^2
EN 36	800	680

Check for the direct shear of crank pin
Shear stress = shear force/shear area
$= 196/(\prod/4 \times d^2)$
Shear sress = $2.4955\ N/mm^2$
Shear sress = $2.4955\ N/mm^2 < 144\ N/mm^2$
Design of crank pin is safe

Fig 2: Crank pin

C. Design of Slider Pin

We know that
T = Force x Radius
4900 = Force x 25
Force = 196 N
This is the force acting on the slider pin in the form of pull exerted by the connecting rod when the pin slides in the guides. Pin has a threading of M10 at the upper end
Thus the core diameter of the pin =8.5 mm

Table 3: Material selection for slider pin

Material Designation	Tensile Strength N/mm^2	Yield Strength N/mm^2
EN 36	800	680

Check for the direct shear of slider pin

Shear stress = shear force/shear area

$= 196/ (\prod/4 \times d^2)$

Shear stress = $3.45\ N/mm^2$

Shear stress = $3.45\ N/mm^2 < 144\ N/mm^2$

Design of slider pin is safe

Fig 3: Slider pin

D. Design of Connecting Rod

Table 4: Material selection for Connecting Rod

Material Designation	Tensile strength N/mm^2	Yield strength N/mm^2
EN 9/C45	600	380

The connecting rod rib is subjected to direct tensile forces during power transmission. Selecting section of rib = (30 x 5) mm is per the system design

Tensile stress (ft) = Load/Area

= 196/(30x5)

As the ft act < ft all

Section of connecting rod is safe under tensile loading

Fig 4: Connecting Rod

E. Design of Eccentric Cam

Outside diameter of hub =50mm

Inside diameter of hub =30 mm

Eccentric can be considered to be a hollow shaft which is subjected to torsion load

Table 4: Material selection for Eccentric cam

Material Designation	Tensile strength N/mm^2	Yield strength N/mm^2
EN 24	1100	880

As per ASME code

$fs_{max} = 148.5\ N/mm^2$

Check for torsional shear failure

$T = (\prod \times fs_{act})/(D_O{}^4 - D_i{}^4/D_O)$

$2.13*10^3 = (\prod \times fs_{act})/(50^4 - 30^4)$

$fs_{act} = 0.1\ N/mm^2$

As $fs_{act} < fs_{all}$ Hence coupling is safe under torsional load

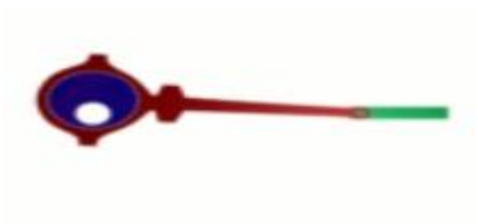

Fig 5: Eccentric Cam

VI. RESULT AND DISCUSSION

In the machine design and development, the aim was to find out the way of cutting four materials with four hacksaw blade in one frame at one time. It is proved that it doesn't affect the rate, as seen in the machine trial experiment. The hypothesis stated that the more power of motor there is in a frame, the faster the cutting of material. This was supported as all of the material cuts at the same time. An experiment that was supposed to last for fewer minutes only lasted for few more seconds, as all of the material used in the trial experiment is wood, metal, pipe. Some may notice the rate of cutting of different material at different time, but this cannot be known exactly as they are of great speed and close eye could not be noticed.

VII. CONCLUSION

As per the above results and discussion we conclude that the problems in conventional hacksaw machine are overcome by the four ways hack saw due to its high efficiency and easy operation. This model of multi way hacksaw is helpful and complete all the expectations needed in the mini industries. As a result benefits would be achieved such as longer tool life, easy chip flow, higher and better machining quality in the machining process

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