DESIGN & FABRICATION OF SEMI-AUTOMATIC MULTIPLE HACKSAW ON A HACKSAW MACHINE

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ABSTRACT

This paper presents the fabrication and concept of a multiple hacksaw blade machine primarily intended for production-based industries. These industries focus on producing valuable goods and services while minimizing production, machinery, and inventory costs. The modern world demands speed and efficiency, but with technological advancement comes significant investment and expenditure. The goal of every industry is to achieve high productivity rates while maintaining product quality and standards at a low average cost. To end this, we have developed a prototype model of a Hacksaw machine with a slider-crank mechanism. This machine can be used in remote locations without regular access to electricity and is designed to be portable for use in various settings. It is suitable for cutting thin metals, wood, PVC pipes, and other materials.

Keyword: - *Multiple Hacksaw Blade Machine, Sider Crank Mechanism, Prototype Model, Thin metals*

1. INTRODUCTION

Currently, various manufacturers offer electrically powered power hacksaw machines with different features, which are commonly utilized in production facilities. While these machines are highly accurate and capable of cutting metal bars made of different materials with speed and precision, they have a significant limitation - they cannot be used for mass production. The production of large quantities of metal bars requires technological and design advancements beyond the capabilities of traditional single-frame power hacksaws. To address this issue, the use of multiple hacksaws for high-speed cutting rates and bulk production has been proposed. Such an approach has the potential to overcome the limitations and flaws of conventional hacksaw machines, offering benefits such as simple working and operating conditions, compatibility, efficiency, and reasonable cost. This machine can be particularly beneficial for small businesses seeking to increase productivity and maximize returns in linked enterprises. Overall, the development of a multiple hacksaw blade machine has the potential to offer significant advancements for the metal cutting industry, particularly for mass production requirements.

1.1 Aim

The aim of this research project is to develop a modernized multiple hacksaw blade machine utilizing a crank mechanism. This machine will enable the uniform cutting of a range of materials, including PVC pipes, metal bars, and wood, with reduced effort requirements. The proposed machine will also have the capability to fulfill the needs of mass production by facilitating greater material cutting capacity. The implementation of this modernized machine is expected to offer significant advantages over existing cutting methods, which often require significant manual labor and result in non-uniform cuts. Overall, the development of a modernized multiple hacksaw blade machine

based on a crank mechanism has the potential to offer significant improvements to the metal cutting industry, including enhanced productivity and more efficient material utilization.

1.2 Objective

The primary objective of this research project is to address the need for increased productivity in metal cutting processes by reducing the requirement for manual labor and minimizing cutting times. This goal will be accomplished through the development of a machine that is both low maintenance and user-friendly, with a focus on minimizing power consumption. By achieving these objectives, the proposed machine has the potential to offer significant advantages over existing cutting methods, which are often labor-intensive and time-consuming. The development of a machine that can achieve high productivity while minimizing manual labor and power consumption would be a significant advancement for the metal cutting industry and could have a substantial impact on manufacturing efficiency.

1.3 History of hacksaw

The utilization of saws for cutting metal has been a widespread practice for a considerable period. However, during the 1880s, Max Flower-Nash introduced noteworthy enhancements in terms of longevity and efficacy. Further progress was made by George N. Clemson, a co-founder of Clemson Bros. Inc, situated in Middletown, New York, United States. Clemson conducted several tests, which entailed altering the dimensions, shapes of teeth, styles of set, and variable heat treatments of blades. Clemson proclaimed substantial improvements to the cutting proficiency of blades and established a significant industrial operation, fabricating hacksaw blades retailed under the trade name Star Hack Saw.[1] In 1898, Clemson obtained US Patent 601947, which delineates various innovations in the hacksaw.[2]

1.4 Problem Identification

The increasing demand for hacksaw blades in various industries such as engineering, real estate, and automobile sectors, among others, has been attributed to the rise of industrialization. These blades are commonly used for cutting materials like PVC pipes, wood, channels, steel bars, and other items in diverse industrial settings. They are also essential in technical institutes, fitting shops, welding shops, general repair shops, and car repair shops. Notably, government agencies such as the Railway, Defense, PWD, Postal & Telegraph, etc., are among the key consumers of hacksaw blades.

Small business activity in India is significantly driven by the manufacturing sector. The high demand for hacksaw blades presents a significant opportunity for new production units in this industry. While electrically and hydraulically powered machines are in use today, their output is unsatisfactory due to their slow cutting rates. The multiple hacksaw blade machine has the potential to enhance productivity by reducing the time required to complete each item. This machine can be especially beneficial for small industries that cannot afford expensive machinery.

Overall, the multiple hacksaw blade machine has emerged as a critical solution to meet the increasing demand for hacksaw blades. Its potential to increase productivity and reduce cutting times makes it an attractive option for small-scale industries. As such, this study aims to explore the feasibility of developing such a machine and its potential impact on the manufacturing industry in India.

2. REVIEW OF LITERATURE

2.1 Solar powered hacksaw machine with safety feature

Rudresh, Sallavoddin, Sandeep, Udayakumar, Dharamendara M. (May 2019)

The project's objective is to develop a system that uses solar energy to operate a DC motor made of wood, PVC pipes, and a metal cutter (hacksaw). [3]

2.2 Theoretical Analysis of Multi-way Power Hacksaw Machine

Kshirsagar Prashant R, Rathod Nayan,Rahate Prashant P,Halaye Prashant P, April 2015 :

According to the research paper, it consists of a single segment vertical electric motor that is rigidly mounted in the middle of a metal base that has been provided. The motor's shaft spins at 90 to 100 rpm while producing 2 HP of power. With a key and key slot association, the circular disc is fixed to the motor shaft. [4]

2.3 Design and Development of Multi-Way Hacksaw Machine

Asif S, Nikhil P. Varghese, Vishnu Anand, Vishnu M. Uttam, Vinod G. Philips (July 2020): -

The main goal of the project is to build a four-way motorized high-speed hacksaw machine. In order to produce more workpieces per hour than a power hacksaw employing a scotch yoke mechanism, the traditional power hacksaw machine is being modified. [5]

2.4 Design and fabrication of four-way hacksaw machine – A design thinking approach

Sowmya Dhanalakshmi, Madhu, Hemachandran, Bharathkumaran, Harisharvinth (July 2020): -

They have created a hacksaw machine prototype model. This project comprises of a linear bushing, a crank, and a slider mechanism. These devices can be utilised in distant areas with regular access to energy. It is intended to be a portable tool that may be used for cutting in a variety of locations. [6]

2.5 Design & Fabrication of Human Powered Multi-Purpose Machine

Rakesh Ambade,Amit Sartabe,Meghraj Arekar,Vaibhav Khachane,Prajakta Gawali,April 2015:

According to their study, it is a pedal-powered gadget established with a simple mechanism that uses a chain and sprocket configuration. The enamel of the wheel and pinion is where the chain is situated. Shaft mounting is done with pedestal bearings. The first mechanical linkage is removed by removing the nut and bolts and the pressure drilling attachment on the v belt. [7]

2.6 Multi Way Hack Saw Machine- A Review

Pratik Awati, Shubham Amrutkar, Satish Sable, Swapnil Wani, Ashwin Dharme (2017):-

The project's goal is to build a multi-way motorized automated high speed hacksaw machine. In order to produce more workpieces per hour than a power hacksaw employing a scotch yoke mechanism, the traditional power hacksaw machine is being modified. [8]

2.7 Material selection and testing of hacksaw blade based on mechanical properties

Prof. Nitinchandra R. Patel, Ravi Thakkar, Miteshkumar Rathwa

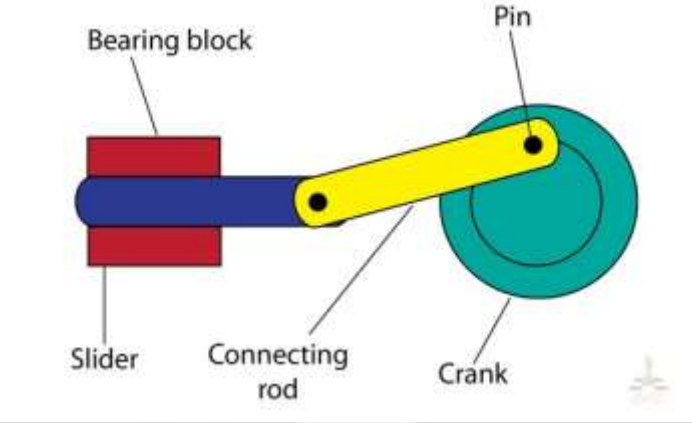
The author of this study article said that choosing the right saw blade's number of teeth per inch is necessary for improved performance and precise cutting. Based on the type of material used, there are four different types of blades: high carbon steel, alloy steel, bi-metallic strip, and high-speed steel blades. Based on material properties, wear resistance, and cutting efficiency, bi-metallic blades are the best of these four for cutting tough materials like aluminum and mild steel bar. [9]

3. PROPOSED METHODOLOGY

3.1 Construction

In the realm of metal fabrication, electric arc welding has been utilized to construct a base that measures 5 feet in breadth, 2 feet in height, and 3 feet in length. The base has been manufactured using mild steel and serves as a stable support for the entire system. Pillow blocks have been employed to establish a connection between a crank and the top of the base. By means of suitable bearings, a pillow block bearing has been utilized as a pedestal to provide support for a rotating shaft. Three parallel hacksaws have been mounted on a galvanized rod. The hacksaws have been connected to a crank mechanism in such a way that the crank and its rod turn the hacksaws back and forth. A small pulley has been affixed to a 1 hp motor that rotates at 1500 rpm. The small pulley has been linked to a larger one using a belt rope. The aforementioned design elements are expected to contribute to the development of an efficient and reliable multiple hacksaw blade machine.

3.2 Working Principle



A. The design of this proposed machine is primarily based on a crank mechanism.
B. The crank mechanism is a mechanical device that enables the transformation of rotary motion to reciprocating motion or vice versa. The mechanism consists of a crankshaft and a connecting rod. The crankshaft is a rotating shaft that contains one or more crankpins, which are located away from the centerline of the shaft. The connecting rod is a rigid rod that connects the crankpin to a reciprocating component, such as a piston. As the crankshaft rotates, the crankpin moves in a circular path, transmitting this motion to the connecting rod, which then imparts a reciprocating motion to the piston or other component. This mechanism finds extensive application in a range of mechanical systems, such as engines and pumps, where reciprocating motion is required. Due to its simple yet effective design, the crank mechanism has played a pivotal role in the development of various machines and equipment in the field of engineering.

3.3 Design

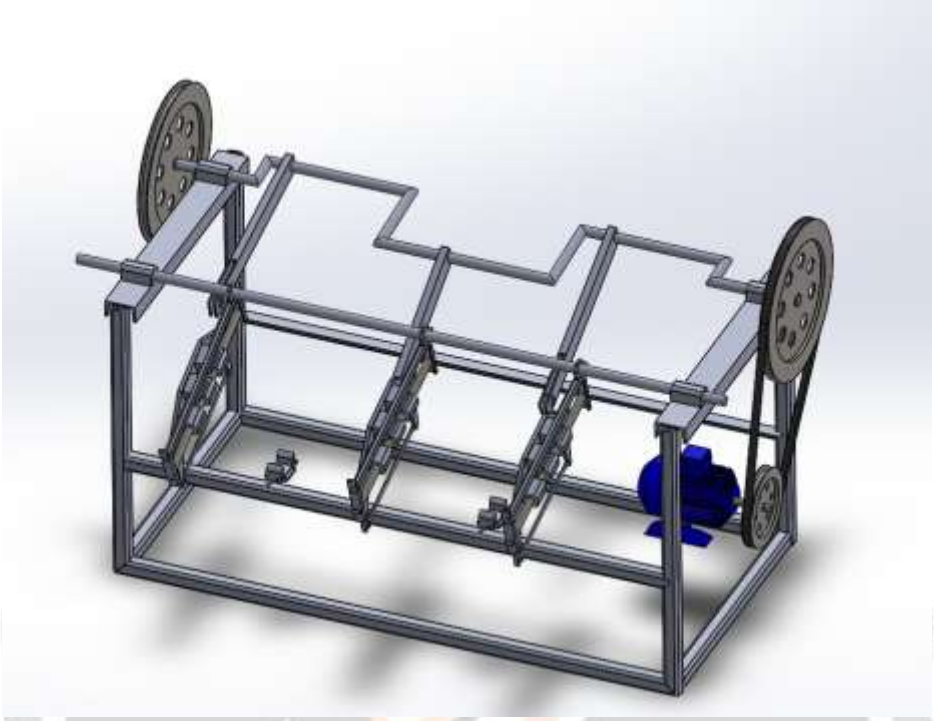


Fig -1: 3D – Model Design

Fig -2: Actual Model Design

3.4 Design Calculations

i. **The RPM of motor = 1500**

N = 1500 rpm

ii. **Power = 1 HP = 746 × 2**

P = 1 HP = 746

Now

P = 2πNT / 60

$$746 = \frac{2 \times 3.14 \times 1500 \times T}{60}$$

$$\therefore T = \frac{746 \times 60}{2 \times 3.14 \times 1500} = \frac{44.760}{9{,}420} = 4.75\ Nm$$

Torque required to cut the material

To find torque specification of Motor Speed.

iii. **Power of motor : 1 HP = 746 watts**

N = 1500 RPM

iv. **Calculating Torque :**

T = (P × 60) / 2ΠIn

= 746 ×60 / 2 × 3.14 × 1440

= 44.760 / 9043.2

∴ T = 4.95 N/m

v. **The RPM (Speed) of pulleys**

1) Driving pulley D_1 = 3”
2) Driven pulley D_2 = 12”

$N_1D_1 = N_2D_2$

$$N_2 = \frac{N_1 D_1}{D_2} = \frac{1500 \times 3}{12} = 375\ RPM \qquad \therefore N_2 = 375\ RPM$$

vi. **RPM of Cutting Feed**

$v_c = \pi DN / 1000$

$$v_c = \frac{\pi DN}{1000}$$

$$v_c = \frac{3.14 \times 40 \times 1500}{1000} = 188.4\ N/m$$

3.4 Machineries

3.4.1. Hacksaw

A hacksaw is a hand-powered, fine-toothed saw that is used to cut metal rods, pipes, brackets, and other items. Plastic may be cut using hacksaws as well. The hacksaw features a handle at one end and a U-shaped frame. At either end of the frame of a hacksaw are tiny pins that hold the blade. In this project, we employed 3 hacksaws, all of which were placed in a single lane.

Fig -3: Hacksaw

3.4.2. Frame Base

The frame base is an essential component of the current project, as it serves as the primary support structure for the remaining components. The base frame is constructed using rectangular mild steel bars that have been cut to the required dimensions. The fabrication process utilized for constructing the foundation structure is arc welding, which is known for its ability to weld on porous and dirty metals. Additionally, this welding process is cost-effective and comparatively quick when compared to other welding techniques. Arc welding can be performed under various weather conditions, including wind and rain. The resulting welds provide a sturdy and reliable junction, making it an ideal welding method for constructing the base frame of the project.

Fig -4: Frame Base

3.4.3. Bench Vice

A vice is a mechanical tool commonly used to hold jobs or work pieces in place during machining operations. It consists of two parallel jaws that can be threaded in and out by a screw and lever mechanism, with one jaw being permanently fixed and the other adjustable. The primary function of a vice is to securely hold an object in place, allowing work to be carried out with precision and accuracy. Typically, a vice is mounted to a table or bench, which provides the necessary force to hold the work piece in place and reduces vibrations that may occur during the machining process. Due to its essential role in machining operations, vices are widely used in a range of industries, including manufacturing, engineering, and construction.

Fig -5: Bench Vice

3.4.4. Plummer Block

In mechanical engineering, a shaft is a rotating element that is used to transmit torque and power between various mechanical components. It is a cylindrical, rod-like component that rotates along its longitudinal axis and is often supported by bearings or other support structures. The shaft is typically inserted into a plummer block, which is a bearing housing that helps to support and guide the rotating shaft. The plummer block is usually fitted with a groove screw that helps to secure the shaft in place and prevent it from moving or wobbling during operation. This mechanism is designed to provide a relatively smooth and stable motion between two parts and is commonly used in a variety of mechanical systems such as engines, pumps, and conveyors.

Fig -6: Plummer Block

3.4.5. DC Motor

Any of a group of rotating electric motors that use direct current (DC) electricity to create mechanical energy is referred to as a DC motor. The most prevalent kinds depend on the forces created by induced magnetic fields brought on by current flowing through the coil. For a portion of the motor's current to sometimes shift direction, almost all types of DC motors contain an internal mechanism that is either electromechanical or electronic.

A DC motor provides the responsive movement of the Hacksaw sharp edge, which is what causes the cutting process to occur. It functions by converting the rotational movement of a basic wrench component into the responding movement of the Hacksaw edge. After the work component has been securely inserted into the pneumatic throw, the DC motor is turned on. By belt-driven capacity transfer to a pulley, the torque of the motor is increased.

Fig -7: DC Motor

Motor Specification	
HP	1 HP
RPM	1500 rpm
VOLTAGE	220

3.4.6. Rectifier

A rectifier is an electrical device that is used to convert oscillating two-directional alternating current (AC) into a single-directional direct current (DC). Rectifiers are available in a wide range of physical configurations, including contemporary silicon-based systems, vacuum tube diodes, and crystal radio receivers. The most basic type of rectifier is the half-wave rectifier, which limits the flow of current to one direction by removing one side of the AC waveform. However, half-wave rectifiers are known to result in an inefficient conversion, as half of the AC power input is wasted. In contrast, full-wave rectifiers utilize all sides of the AC waveform, thereby offering a more efficient conversion option. Due to their importance in converting AC to DC power, rectifiers are widely used in various electrical and electronics applications.

Fig -8: Rectifier

3.4.7. Dimmer

A dimmer is an electronic device that is commonly used to adjust the brightness of a light source connected to a fixture. By altering the waveform of the voltage supplied to the bulb, a dimmer is able to decrease the output of light. In the context of a multiple hacksaw blade machine, the idea of using a dimmer to regulate the speed of the DC motor is a feasible approach. The dimmer would be connected to a rectifier, which in turn would be linked to the DC motor. By manipulating the waveform of the voltage supplied to the motor, the dimmer would be able to control the speed of the motor, which in turn would determine the cutting speed of the hacksaw blades. The use of a dimmer in this capacity has the potential to offer greater flexibility in the operation of the multiple hacksaw blade machine, allowing for precise adjustments in cutting speed and improved overall performance.

Fig -9: Dimmer

3.4.8. Pully Wheel

A pulley wheel, when used alone, requires more force to lift a load from the ground than the actual weight of the load. However, when the pulley wheel is fixed to an immovable object such as a wall or ceiling, it acts as a first-class lever with the fulcrum at the axis, but with the bar being replaced by a rope. The advantage of using a pulley wheel is that it eliminates the need to physically lift or push the load. The disadvantage is that more force is required to lift the load than its actual weight. These principles of pulley systems have been widely utilized in various industries, such as construction, transportation, and manufacturing, to facilitate the lifting and moving of heavy loads. Further research could explore how pulley systems can be optimized for specific applications to increase efficiency and reduce the amount of force required to lift loads.

Fig -10: Pulley Wheel

3.4.9. V-Belt

The V-belt is the most commonly used drive belt for power transmission in mechanical systems. Its primary function is to transfer energy from an initial power source, such as a motor, to a driven unit. V-belts offer several advantages over other types of belts, including superior traction, efficient speed transfer, optimal load distribution, and extended service life. These attributes make V-belts a popular choice in a variety of industrial and commercial applications where reliability and durability are essential. By effectively transmitting power from one component to another, V-belts play a critical role in ensuring the smooth and efficient operation of complex mechanical systems.

Fig -11: V-Belt

3.4.10. Rubber pad

Rubber pads are widely used to minimize the amount of vibration transmitted to a surface by absorbing the vibrations produced by a machine. These pads are composed of a special type of rubber material that is designed to absorb and dampen the vibrations generated by machinery during operation. The use of rubber pads can significantly reduce noise levels and prevent damage to the machine and surrounding equipment. This is achieved by isolating the machine from the surface on which it is mounted, thus reducing the transfer of vibration energy. Rubber pads are commonly used in a variety of industrial and commercial applications, including machinery, heavy equipment, and power tools, where vibration reduction is essential for safe and efficient operation. By absorbing and dissipating vibration energy, rubber pads play a critical role in maintaining the stability and integrity of mechanical systems, while also minimizing the risk of injury or damage caused by excessive vibration.

Fig -12: Rubber Pad

4.5 Precautions

There are several unique safety measures that must be followed while using sawing machines. These are several safety measures that must be taken.

a) Keep your hands away from the hacksaw machine's saw blade.
b) While removing and installing the blades, care must be used.
c) Make sure you turn off the power source before removing or replacing saw blades.
d) Use only functional devices. Report suspicious machinery right away.
e) Avoid cutting materials that cannot be securely held in the vice without adopting safety measures.
f) Never let the machine run unsupervised.
g) Turn off the machine after the job is done. Keep the machine and work area safe, orderly, and clean.
h) Do not clean the machine using pressurized air.

4.6 Advantages

- Streamlined in production
- Easy to construct
- Making repairs and changes is not difficult
- It is possible to concurrently cut many work parts
- The cutting procedure requires less time
- Rise in output
- One motor is responsible for all functions
- Proficient operators are not required
- Cleaning up is simple

4.7 Limitations

- Workpiece loading and unloading are done manually
- Additional moving components
- May only be utilized in villages and small-scale industries
- Every gear and tools need to be lubricated
- The hacksaw blades need to be changed often.

4.8 Applications

This motorized high-speed hacksaw machine is versatile in its applications, finding widespread use across various fields. Its adaptability makes it a suitable cutting tool for a diverse range of industries, from small to medium-sized facilities, as well as in workshops and production-related businesses. The machine's ability to cut through different materials, such as wood, steel, PVC pipes, and others, makes it a valuable asset to educational establishments, tool storage, and rolling mills. With its multi-purpose functionality, this hacksaw machine has proven to be a reliable and effective cutting tool in various fields.

4.9 Future Scope

This motorized high-speed hacksaw machine has the potential to be widely used in major industries. Further research can be done to enhance productivity and facilitate cutting of metal bars. The machine is designed to withstand vibrations, eliminates any jerking risks, and requires no specialized training to operate. Its application is widespread, especially in the manufacturing of machines, providing alternatives to labor-intensive tasks. With the help of micro-controllers, the machine can be fully automated. The operator does not need to measure the length of the workpiece manually, and data can be inputted via a keypad and LCD display. The maximum size of a round or square bar can be increased by increasing the motor power and size of various elements. In conclusion, this machine is a promising innovation that can significantly enhance the efficiency and productivity of various industrial applications.

5. RESULT

PVC pipe, wood, and MS hollow pipe were tested on this machine to cut the whole diameter using a functional hacksaw blade. The cut was seen to be clean, straight, and to have a smooth surface.

Table -1: Cutting Analysis

Sr. No.	Material	Size	Cutting Time (sec)
1	PVC Pipe	25 mm	30
2	Wood	2 x 2	90
3	MS Hollow square pipe	1 x 1	60

6. CONCLUSIONS

The conventional hacksaw machines often face a multitude of problems, such as low efficiency, difficulty in operation, and high cost. In order to overcome these challenges, a proposed model of a multiple blade hacksaw machine has been developed. This model has demonstrated high efficiency, ease of operation, and affordability, making it a promising solution for mini-industries. The multiple blade hacksaw machine has the potential to meet all the expectations and requirements of modern industrial settings. In conclusion, this research suggests that the proposed model of a multiple blade hacksaw machine is a viable alternative to conventional hacksaw machines for industries looking to increase productivity and efficiency while reducing costs.

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8. REFERENCES

[1] Woodley, G. MacLaren (1955). "The Clemson Story". The Historical Society of Middletown. Archived from the original on 18 May 2014. Retrieved 18 May 2014.

[2] "US Patent: 601,947". Google Patents. April 5, 1898. Retrieved 18 May 2014.

[3] "SOLAR POWERED HACKSAW MACHINE WITH SAFETY FEATURE", International Journal of Emerging Technologies and Innovative Research (www.jetir.org | UGC and issn Approved), ISSN:2349-5162, Vol.6, Issue 5, page no. pp108-113, May-2019, Available at: http://www.jetir.org/papers/JETIRBZ06018.pdf

[4] Prof. Kshirsagar Prashant R, **"THEORETICAL ANALYSIS OF MULTI-WAY POWER HACKSAW MACHINE"**,‖ International Journal of Research in Advent Technology, Vol.3, No.4, April 2015 E-ISSN: 2321-9637

[5] Nikhil P Varghese, Asif S, Vishnu Anand, Vishnu Uttam, Vinod G Philips. **"DESIGN AND DEVELOPMENT OF MULTI-WAY HACKSAW MACHINE"**, International Journal of Engineering Development and Research (IJEDR), ISSN:2321-9939, Vol.8, Issue 7, pp.5610-5615, July 2020, URL :http://www.ijedr.org/papers/IJCRT2007627.pdf

[6] Sowmya Dhanalakshmi.C; Madhu P; Hemachandran N; Bharathkumaran G; Harisharvinth LB. **"DESIGN AND FABRICATION OF FOUR-WAY HACKSAW MACHINE – A DESIGN THINKING**

APPROACH". International Research Journal on Advanced Science Hub, 2, 7, 2020, 126-130. doi: 10.47392/irjash.2020.76

[7] Rakesh Ambade, Amit Sartabe, Meghraj Arekar, Vaibhav Khachane, Prajakta Gawali , **"DESIGN & FABRICATION OF HUMAN POWERED MULTI-PURPOSE MACHINE"**, International Journal of Advanced Technology in Engineering and Science, ISSN(Online):2348-7550,Volume No 03,Special Issue No.01,April 2015.

[8] Pratik Awati, Shubham Amrutkar, Satish Sable, Swapnil Wani, Ashwin Dharme **"MULTI WAY HACK SAW MACHINE- A REVIEW",** International Journal on Theoretical and Applied Research in Mechanical Engineering ISSN (Print): 2319-3182, Volume -6, Issue-1-2, 2017

[9] Prof. Nitinchandra R. Patel, Mohammad A. Vasanwala, Balkrushna B. Jani, Ravi Thakkar, Miteshkumar D. Rathwa, **"MATERIAL SELECTION AND TESTING OF HACKSAW BLADE BASED ON MECHANICAL PROPERTIES",** International Journal of Innovative Research in Science, Engineering and Technology, ISSN: 2319-8753, volume 2, Issue 6, June 2013.

[10] R.S.Khurmi, J.K.Gupta, (2012) **"THEORY OF MACHINES"**, Page no. 143-168

[11] Dr. V.P. Singh, (2007) **"MECHANICAL VIBRATION"**, Page no. 145-162