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Double Acting Hacksaw Machine

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ABSTRACT
This project is the design and construction of double acting hacksaw for Cutting wood and metal to different length. The power is given by a motor it drives the pulley which holds the main screw. The main screw holds two connecting rods. The other ends of the connecting rods are connected to the frame of the hack saws. The hacksaws are constrained to move in a straight path with the help of sliders. The frame is designed to provide the necessary motion . In this double acting hacksaw machine we can able to cut materials such as wood, steel, etc. This machine makes the cutting operation much easier and also it reduces the production time. Since two work pieces can be cut at the same time the total time is also reduced. The handling of the machine is much simple.

I. INTRODUCTION

1.1 What Is Hacksaw

A hacksaw is a fine-toothed saw, originally and principally for cutting metal. They can also cut various other materials, such as plastic and wood; for example, plumbers and electricians often cut plastic pipe and plastic conduit with them.

The first flint saws appeared during the early Paleolithic Era, between 60,000 and 10,000 B.C. Stone saws and composite saws made of stone bladelets or "microliths" set into a bone handle also were made during this time. The first metal blades were made possible by the discovery of copper about 4,000 years ago.

As the Iron Age began, the weaker copper and bronze were discarded and raked teeth were finally made possible. Eventually it became apparent that increasing the number of teeth in a saw increased the efficiency of its use. Small saws were used for carpentry, with the Asian style of pull-saws being specifically used by the Ancient Egyptians. Hieroglyphics discovered in Egyptian monuments record the Egyptians' use of the saw in their methods of furniture making. Adjustments in saw design were made according to a saw's intended application. For example, spaced teeth allowed the saw to double as a rake after the cutting stroke, removing sawdust from the developing "kern" or cut.

Saws continued to be improved as innovations in metallurgy were developed. Leonardo da Vinci invented a marble saw during the fifteenth century, and many developers in Europe and abroad took advantage of improvements in steel to create a better cutting edge. Throughout the seventeenth century, the strongest blades were still the narrowest. The bow saw—named for its structural similarity to the bow and arrow—continued to be popular because of this limitation. The popularity of the wooden frame saw among the early European settlers in America has been attributed to the scarcity of metal in the colonies at that time, as well as to the lack of wide-rolled steel.

With the advent of the Industrial Revolution, stronger, more durable saws were produced. For example, various forms of the circular saw were being made during the early eighteenth century, though the first patent in the United States was granted to Benjamin Cummins of New York in 1814. Today, a wide variety of manual and power saws are produced for consumer as well as commercial use.

Tempered, high-grade tool steel, alloyed with certain other metals, is the main material used to manufacture the saw blade. Handles used to be made solely of wood, but modern tools can also be made with molded plastic.

1.3 Types Of Hacksaw

There are two types of hack saws they are

1. Hand saw
2. Power hacksack

1.3.1 HAND SAW

In woodworking and carpentry, hand saws, also known as "panel saws", "fish saws", are used to cut pieces of wood into different shapes. This is usually done in order to join the pieces together and carve a

wooden object. They usually operate by having a series of sharp points of some substance that is harder than the wood being cut. The hand saw is a bit like a tenon saw, but with one flat, sharp edge.

Fig 1.3.1 Hand saw

Materials for saw blades have varied over the ages. There were probably bronze saws in the time before steel making technology became extensively known and industrialized within the past thousand years or so. Sometimes cultures developed two main types of saw teeth: the 'cross cut' saw teeth and the 'rip' saw teeth. These cut into the wood using different mechanisms. Wood is composed of many long cells running length-ways. Thus, crosscut saws have saw teeth that are usually shaped, often with a metal file, in such a way that they form a series of tiny knife like edges .The wood cells are contacted by the knife-edge of the tooth and cut. Rip saws, on the other hand, are usually shaped so that they form a series of tiny chisel-like edges. The wood cells are contacted by the chisel and 'ripped' apart from the bundle of other cells. Of course either saw can be used either way.

Saws can also be considered 'pull cut' or 'push cut'. Ancient Egyptian saws have been said to be pull cut. Modern European saws (and those in European-derived cultures like that of the United States) generally have 'push cut' handsaws. Japanese handsaws are usually pull-cut and are still used today. In the 1930s, the Kulibert-Stanley Tool Company popularized an inexpensive saw. Many woodworkers have various theories about the advantages and disadvantages of pull vs. push, and even experts will disagree on these matters, including accuracy of cut, power available for cut, straightness of line, thinness of kerf (the slit in the wood that is made during cutting), etc

1.3.2 Power Hacksaw

A power hacksaw is a machine used to cut across materials like metal and bone. Aluminum, brass, and mild steels are other materials the power hacksaw is capable of slicing through. It comes in various types, such as utility, heavy duty, and high-production styles. In most machine shops, these tools are used due to the reciprocating motions that are able to cut through diameters of more than ten inches (25.4 cm) in size.

Power hacksaws have an arm section, which is the rotating portion of the machine that cuts the material on a backward stroke. This is the part of the tool where the blade is located. To hold the object to be cut together, the tool is equipped with a vice that has handles one can turn to tighten or loosen the hold on the material. It is a powerful part of the hacksaw that locks the object in position for cutting. An emergency foot switch and coolant are also part of the tool as safety precautions.

Fig 1.3.2 Power hacksaw

The power hacksaw blades are used to cut through the material or object and are usually graded according to the steel it is made of and the number of teeth that it has. As a cheaper alternative for the metal blades, some manufacturers use carbon steel materials. Each blade of the power hacksaw is composed of 14 to 24 teeth per inch of the blade. More teeth present in the hack blade produce a smoother output. Blades of hacksaw devices can become brittle; proper care should be taken to prevent this.

Chapter 2
II. MAIN COMPONENTS USED IN DOUBLE ACTING HACKSAW

- Electric Motor
- Pulley
- Belt
- Hacksaw
- Hacksaw Blade

2.1 Electric Motor

An electric motor is an electrical machine that converts electrical energy into mechanical energy. The reverse of this would be the conversion of mechanical energy into electrical energy and is done by an electric generator.

2.1.1 **Types**

The primary classification of motor or types of motor can be tabulated as shown below,

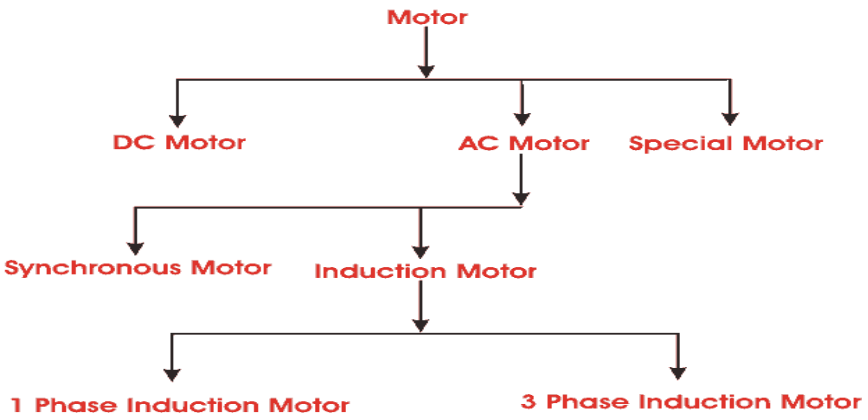

Fig 2.1.1 Types of motors

2.1.2 Ac Motor

An AC motor is an electric motor driven by an alternating current (AC). The AC motor commonly consists of two basic parts, an outside stationary stator having coils supplied with alternating current to produce a rotating magnetic field, and an inside rotor attached to the output shaft producing a second rotating magnetic field. The rotor magnetic field may be produced by permanent magnets, reluctance saliency, or DC or AC electrical windings.

Less commonly, linear AC motors operate on similar principles as rotating motors but have their stationary and moving parts arranged in a straight line configuration, producing linear motion instead of rotation.

Operating Principle

When an AC motor is in steady-state rotation (motion), the magnetic fields of the rotor and stator rotate (move) with little or no slippage (near synchrony). The magnetic forces (repulsive and attractive) between the rotor and stator poles create average torque, capable of driving a load at rated speed. The speed of the stator rotating magnetic field (ω_s) and the speed of the rotor rotating magnetic field (ω_r), relative to the speed of the mechanical shaft (ω_m), must maintain synchronism for average torque production by satisfying the synchronous speed relation (i.e., $\pm\omega_s \pm \omega_r = \omega_m$). Otherwise, asynchronously rotating magnetic fields would produce pulsating or non-average torque.

2.1.3 Single Phase Induction Motor

A single phase motor has only one stator winding. This winding generates a field which merely pulsates, instead of rotating. When the rotor is stationary, the expanding and collapsing stator field induces currents in the rotor. These currents generate a rotor field opposite in polarity to that of the stator. The opposition of the field exerts a turning force on the upper and lower parts of the rotor trying to turn it 180° from its position. Since these forces are exerted through the center of the rotor, the turning force is equal in each direction. As a result, the rotor does not turn. If the rotor is started turning, it will continue to rotate in the direction in which it is started, since the turning force in that direction is aided by the momentum of the rotor.

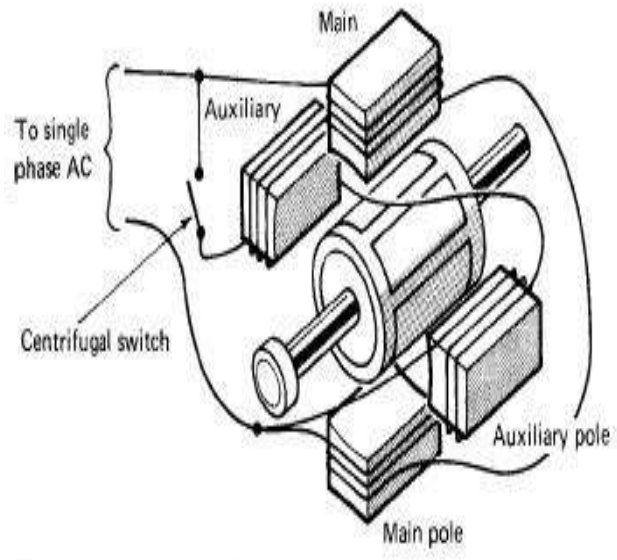

Fig 2.1.3 Single phase induction motor

Construction Of Single Phase Induction Motor

Like any other electrical motor asynchronous motor also have two main parts namely rotor and stator.

Stator: As its name indicates stator is a stationary part of induction motor. A single phase ac supply is given to the stator of single phase induction motor.

Rotor: The rotor is a rotating part of induction motor. The rotor is connected to the mechanical load through the shaft. The rotor in single phase induction motor is of squirrel cage rotor type.

in case of asynchronous motor the stator have two windings instead of one as compare to the single stator winding in three phase induction motor.

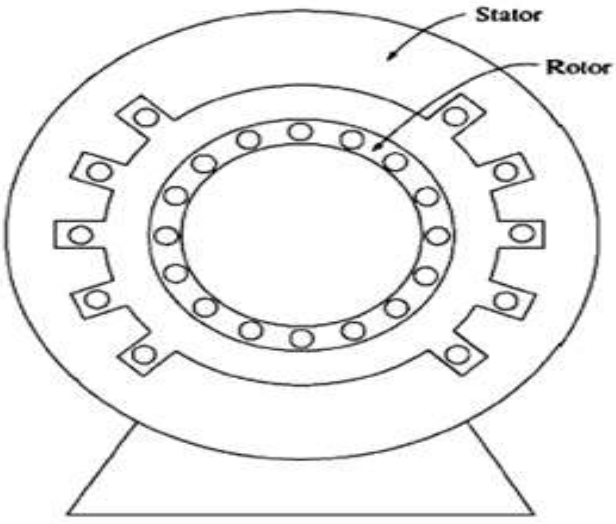

Fig 2.1.4 Stator and Rotor

Stator Of Single Phase Induction Motor

The stator of the single phase induction motor has laminated stamping to reduce eddy current losses on its periphery. The slots are provided on its stamping to carry stator or main winding. In order to reduce the hysteresis losses, stamping are made up of silicon steel. When the stator winding is given a single phase ac supply, the magnetic field is produced and the motor rotates at a speed slightly less than the synchronous speed Ns which is given by

The construction of the stator of asynchronous motor is similar to that of three phase induction motor except there are two dissimilarity in the winding part of the single phase induction motor. Firstly the single phase induction motors are mostly provided with concentric coils. As the number of turns per coil can be easily adjusted with the help of concentric coils, the mmf distribution is almost sinusoidal. Except for shaded pole motor, the asynchronous motor has two stator windings namely the main winding and the auxiliary winding. These two windings are placed in space quadrature with respect to each other.

Rotor Of Single Phase Induction Motor

The construction of the rotor of the single phase induction motor is similar to the squirrel cage three phase induction motor. The rotor is cylindrical in shape and has slots all over its periphery. The slots are not made parallel to each other but are bit skewed as the skewing prevents magnetic locking of stator and rotor teeth and makes the working of induction motor more smooth and quieter. The squirrel cage rotor consists of aluminium, brass or copper bars. These aluminium or copper bars are called rotor conductors and are placed in the slots on the periphery of the rotor.

The rotor conductors are permanently shorted by the copper or aluminium rings called the end rings. In order to provide mechanical strength these rotor conductor are braced to the end ring and hence form a complete closed circuit resembling like a cage and hence got its name as "squirrel cage induction motor". As the bars are permanently shorted by end rings, the rotor electrical resistance is very small and it is not possible to add external resistance as the bars are permanently shorted. The absence of slip ring and brushes make the construction of single phase induction motor very simple and robust.

Working Principle Of Single Phase Induction Motor

NOTE: We know that for the working of any electrical motor whether its ac or dc motor, we require two fluxes as, the interact of these two fluxes produced the required torque, which is desired parameter for any motor to rotate.

When single phase ac supply is given to the stator winding of single phase induction motor, the alternating current starts flowing through the stator or main winding. This alternating current produces an alternating flux called main flux. This main flux also links with the rotor conductors and hence cut the rotor conductors. According to the Faraday's law of electromagnetic induction, emf gets induced in the rotor. As the rotor circuit is closed one so, the current starts flowing in the rotor. This current is called the rotor current.

This rotor current produces its own flux called rotor flux. Since this flux is produced due to induction principle so, the motor working on this principle got its name as induction motor. Now there are two fluxes one is main flux and another is called rotor flux. These two fluxes produce the desired torque which is required by the motor to rotate.

2.2 Pulley

A pulley is a wheel on an axle or shaft that is designed to support movement and change of direction of a taut cable or belt along its circumference. Pulleys are used in a variety of ways to lift loads, apply forces, and to transmit power. In nautical contexts, the assembly of wheel, axle, and supporting shell is referred to as a "block."

2.2.1 Types Of Pulley

There are three types of pulleys:

1.) Fixed Pulley
2.) Movable Pulley
3.) Combined Pulley

2.2.2 Fixed Pulley

A fixed pulley is the only pulley that when used individually, uses more effort than the load to lift the load from the ground.The fixed pulley when attached to an unmovable object e.g. a ceiling or wall, acts as a first class lever with the fulcrum being located at the axis but with a minor change, the bar becomes a rope.
The advantage of the fixed pulley is that you do not have to pull or push the pulley up and down.
The disadvantage is that you have to apply more effort than the load

Fig 2.2.2 pulley

2.3 Belt

A belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently, or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel. In a two pulley system, the belt can either drive the pulleys normally in one direction (the same if on parallel shafts), or the belt may be crossed, so that the direction of the driven shaft is reversed (the opposite direction to the driver if on parallel shafts). As a source of motion, a conveyor belt is one application where the belt is adapted to carry a load continuously between two points.

2.3.1 Types Of Belt

The major types of belts used are

- Flat belt
- V belt
- Toothed belt

2.3.2 V Belt

Cogged V belts solved the slippage and alignment problem. It is now the basic belt for power transmission. They provide the best combination of traction, speed of movement, load of the bearings, and long service life. They are generally endless, and their general cross-section shape is trapezoidal.

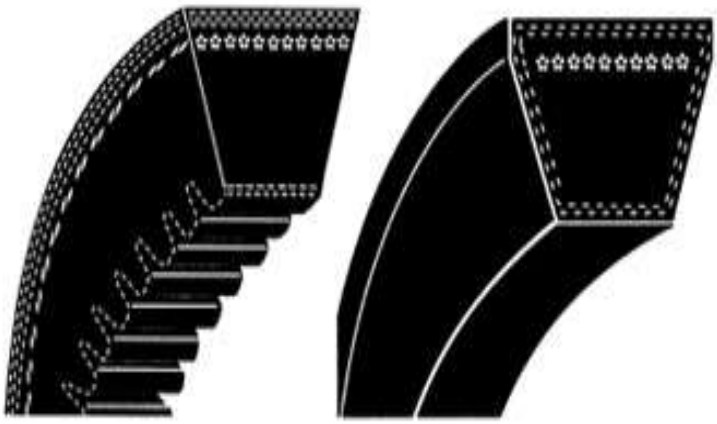

Fig 2.3.2 V-belts

2.4 Hacksaw

A hacksaw is a fine-toothed saw, originally and principally for cutting metal. They can also cut various other materials, such as plastic and wood; for example, plumbers and electricians often cut plastic pipe and plastic conduit with them. There are hand saw versions and powered versions (power hacksaws).

Most hacksaws are hand saws with a C-shaped frame that holds a blade under tension. Such hacksaws have a handle, usually a pistol grip, with pins for attaching a narrow disposable blade. The frames may also be adjustable to accommodate blades of different sizes.

Fig 2.4 Hacksaw

2.5 Hacksaw Blade

2.5.1 Technical Information For The Hacksaw Blades

How to Choose the Right Type of Hacksaw Blades

Choosing of the hacksaw blade with the correct tooth number per inch depends on dimensions and type of the cutting material.

14 teeth/ 25 mm - cutting of thin materials of all types as tubes, pipes, profiles etc.
10 teeth / 25 mm - cutting of all material types with small and medium dimensions
6 teeth / 25 mm - cutting of all material types of greater thickness
4 teeth / 25 mm - cutting of soft material types of greater thickness

2.5.2 Recommended Teeth Per 25mm (Tpi) For Each Material Type:

Table 1:

Material	Material diameter (mm)		
	10-30	30-100	100-250
	Teeth per inch (25mm)		
Free machining steel Building irons Structural steel	14-8	8-6	6-4
Heat-treated steel Nitridated steel	14-8	8-6	6-4
Unalloyed tool steel Alloyed tool steel	10-8	6-4	4
Spring steel	14-8	8-6	6-4
High temperature steel Stainless steel	8-6	6-4	6-4
Malleable cast iron to 200HB Gray iron over 200HB	8-6	6-4	4
Cast iron	10-8	8-6	6-4
Dural Bronze Aluminium Brass	6-4	6-4	6-4

Small tooth number is suitable for thicker material cutting and greater tooth number is better for thin profile cutting.

2.5.3 How To Use Power Hack Saw Blades Properly

1. It is important to pay the same attention to power hack saw blades as to any other tools.
2. Keep the machine in good technical condition. It is especially needed to check if:
a. the lifting arm and its function are in order,
b. oil pump of the lifting arm is clean and without air bubbles.
3. Tighten the hack saw blade in the machine in correct position and straighten it properly.
4. Tighten the cutting material firmly into the clamps so that as many teeth as possible cut (at least 4, maximum 30).
5. While bundle cutting (more pieces at once) make sure each piece is firmly tightened.
6. While cutting metal castings make sure you remove foundry sand from the surface with bastard file or steel brush. Sand can cause the hack saw to run dull very fast.
7. While staring the machine, lower the saw frame carefully and change the pressure or lower the feed speed for several first cuts (only when new blade is used).
8. Do not use too high or too low pressure.
9. Always use cooling fluids while cutting.

2.5.4 Defects And Their Causes

1. **Fast blunting**
   - if wrong teeth number is chosen
   - if saw blade is not tightened accurately
   - if cutting speed is too high- especially while cutting hard metals
   - if pressure is too high - teeth go blunt fast
   - insufficient pressure - teeth grate but do not cut in
   - insufficient cooling
   - if defects in mechanism for reverse cutting occur

2. **Teeth breaking**
   - tooth pitch is too small (teeth number per 25mm) while cutting thin elements
   - if cutting sharp edges or thin- walled elements when not even 4 teeth are in cut at once.
   - if material is not tightened well

3. **Breaking of saw blade**
   - unqualified straightening of saw blade in machine frame
   - improperly chosen hack saw blade for high feed
   - careless lowering of machine frame
   - cutting material is not tightened properly
   - driving new hack saw into cutting line previously made by used hack saw blade.
   - jammed material while finishing the cut
   - defective bearings in machine or defective stroke

   By choosing the right hack saw blade in correct dimensions for cutting particular material type you will reach the most economical cutting performance. Do not forget to follow the above instructions while using hack saw blades.

CHAPTER 3

III. FABRICATION OF DOUBLE ACTING HACKSAW MACHINE

3.1 Components Double Acting Hacksaw Machine Set Up

The major components of double acting hacksaw are,

- Single phase ac motor
- Pulley
- V-belt
- Connecting rod
- Hacksaw
- Frame
- Work piece
- Vice

3.1.1 Single Phase Ac Motor

A single phase motor has only one stator winding. This winding generates a field which merely pulsates, instead of rotating. When the rotor is stationary, the expanding and collapsing stator field induces currents in the rotor. These currents generate a rotor field opposite in polarity to that of the stator. The opposition of the field exerts a turning force on the upper and lower parts of the rotor trying to turn it 180° from its position. Since these forces are exerted through the center of the rotor, the turning force is equal in each direction. As a result, the rotor does not turn. If the rotor is started turning, it will continue to rotate in the direction in which it is started, since the turning force in that direction is aided by the momentum of the rotor.

3.1.2 pulleya

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The advantage of the fixed pulley is that you do not have to pull or push the pulley up and down.

The disadvantage is that you have to apply more effort than the load

3.1.3 V-Belt belts

solved the slippage and alignment problem. It is now the basic belt for power transmission. They provide the

best combination of traction, speed of movement, load of the bearings, and long service life. They are generally endless, and their general cross-section shape is trapezoidal.

3.1.4 Connecting Rod

The connecting rod is used to connect the main screw and handle of hack saw . The metal is made tempered steel ,which is hardened. The connecting rod undergoes fatigue and tensile load. So the steel has to be hardened.

3.1.5 Hacksaw

A hacksaw is a fine-toothed saw, originally and principally for cutting metal. They can also cut various other materials, such as plastic and wood; for example, plumbers and electricians often cut plastic pipe and plastic conduit with them. There are hand saw versions and powered versions

3.1.6 Frame

The frame is made of mild steel material. The cross section of mild steel is square. Square tube material is used because it is hard, withstands tensile and compressive loads . The cost is comparitively less to other materials. The frame carries motor , pulley ,connecting rod, hacksaw , vice and the work piece.

3.1.7 Vise

A vise is a mechanical apparatus used to secure an object to allow work to be performed on it. Vises have two parallel jaws, one fixed and the other movable, threaded in and out by a screw and lever.

3.2 Fabrication Of Double Acting Hacksaw Machine

- It consist of single phase ac motor which is fixed to the frame.
  - The spindle of the motor is connected to the pulley with the help of the stepped v belt
  - The pulley is also connected to the center of the frame
  - A plywood of circular shape is cut and attached to the driven pulley with the help of bolts and nuts
  - A main screw is connected to the pulley at one of its extreme end
  - Two connecting rods are connected to the main screw at its one end
  - The other ends of connecting rod are connected to handle of the hacksaw
  - The hacksaw is constrained to move along a linear path
  - The hacksaw act as slider with the help of two rings which is welded on the top of hacksaw frame
  - A spring arrangement is provided at the two extreme ends of the frame
  - The entire setup is held together with the help of a frame

Fig 3.2.1 Pulley and plywood

Fig 3.2.2 Ac motor

Fig 3.2.3 Motor with pulley in main frame

Fig 3.2.4 Main frame connected with a side frame

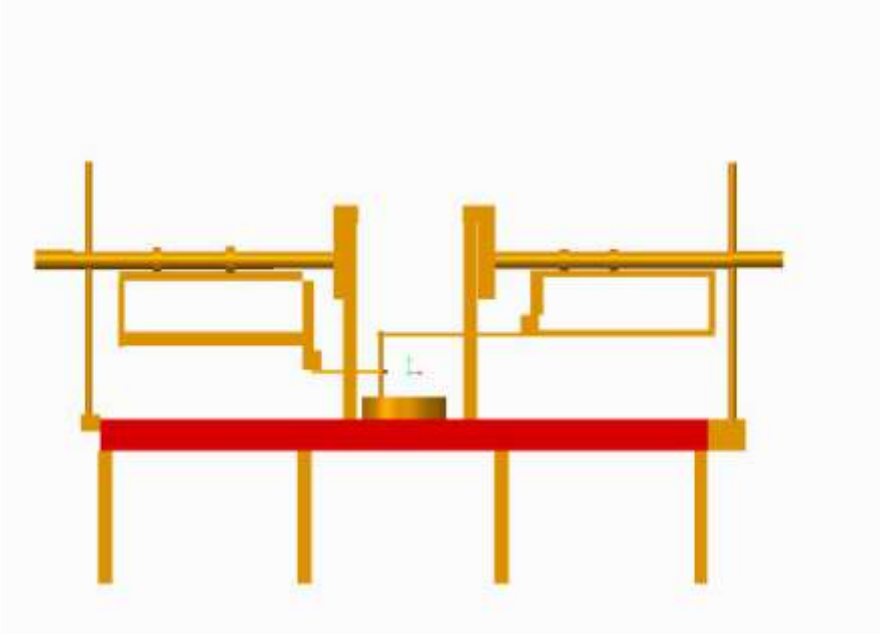
Fig 3.2.5 Main frame attached with two side frames

3.3 Working Of Double Acting Hacksaw Machinethe Single Phase Ac Motor Is Connected To The Power Supply

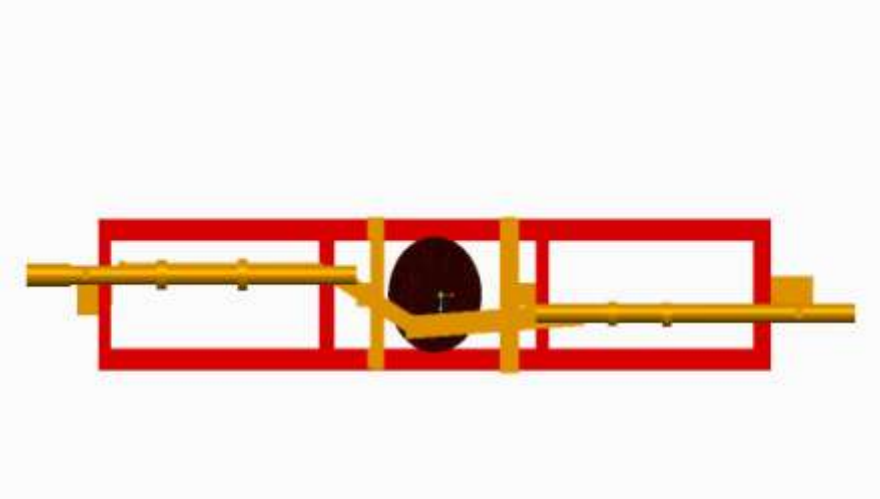
- The motor is switched on
- The motor rotates with the speed of 800 rpm which in turn rotates the pulley which is connected to the motor with the help of toothed v belt
- The main screw rotates along with the pulley
- The two connecting rods which are connected to the main screw rotates along with the main screw
- The hacksaw handle which is connected to the other end of the connecting rod reciprocates along the constrained path
- The frame which holds the hollow pipe acts as the guide way for the reciprocating motion of the hacksaw frame

- The other end of the hollow pipe is connected to the handle which is used to give the feed manually
- An open coil helical spring is provided at the bottom of the handle which acts as a stopper and also to control the feed rate
- The work piece is held with the help of vice which is attached to the frame
- The handle lowered to give the gradual depth of cut

Creo Front View



3.4.2 Top View



3.4.3 3d View

Chapter 4

4.1 Advantages Of Double Acting Hacksaw Machine

- This process is suitable for cutting all materials.
- Low initial investment
- Very simple design
- Equipment is safe to operate
- High accuracy and good surface finish can be easily obtained
- Time taken for the process is low
- Work piece can be easily handled
- Setting up and rejection of work piece is easy
- High skilled operators are not needed

4.2 Disadvantages Of Double Acting Hacksaw Machine

- High specific energy consumption
- Accuracy is less
- Heat is generated during the process
- The hacksaw blades has to be replaced often

4.3 Applications Of Double Acting Hacksaw Machine

- It is used for cutting wood, steel, PVC pipes and many other materials usind double acting hacksaw.
- Tool Rooms
- Educational Institutes
- Workshops
- Rolling Mills Etc

CHAPTER 5
IV. DESIGN CALCULATIONS

Calculation The torque of the AC motor must be increased so as to bring about the necessary power for cutting of work-pieces efficiently. This is achieved by coupling the rotor of the AC motor to a pulley by a belt drive. So, this will reduce the rotating speed while increasing the torque. The pulley is coupled to the reciprocating mechanism.

Motor,
driving Pulley (1) diameter= 0.0508 m
Driven Pulley (1) diameter= 0.2286 m Therefore,
Reduction Ratio= 4.5:1
Speed of motor, N (driving) = 920 rpm
Driven Pulley speed N (1) = 204.44 rpm
Power = 0.25 hp = 0.186 kW
Power = $2\pi NT/60$
Torque T (Driving) = 1.935 Nm
Therefore, Torque T (Driven) (1) = 8.7113 Nm Driving Pulley (2) diameter= 0.0889 m
Driven Pulley (2) diameter= 0.2286 m
Driving Pulley speed N (2) = 204.44 rpm
Driven Pulley speed N (driven) (2) = 79.5 rpm
Torque T (Driving) (2) = 8.7113Nm
Therefore, Torque T (Driven) (2) = 22.401 Nm

CHAPTER 6
V. RESULTS AND DISCUSSION

The double acting hacksaw is able to cut materials like wood , ms tubes , and other materials . It makes the cutting process much easier as compared to the normal manual handsaw . Machine is driven by 120 W and 920 rpm electric motor. Test was carried out on machine using different metal. For the loaded test, a shaft of diameter 25 mm and length 12 inch and the material of the shaft was mild steel was clamped on the vice of the machine. It took the machine 240 seconds to cut the with a new hacksaw blade. The cut was observed to be neat and straight. Recommendation has been made on the operation and parameters of the machine. Suggestion have been offered on overall machine performance optimization and further work on the machine.

The machine can be fully automated by using Microcontroller. In fully automated machine the operator need not measure the length of the work-piece that is to be cut and to load and unload the work-piece each time after a piece has been cut.

VI. CONCLUSION

Currently many electrically operated power hacksaw machines manufactured by different companies with different specifications are available for the use in shop floor. These machines are so designed that they can cut metal or plastic rods/bars with minimum time made up of different materials but they have one and major disadvantage that they can cut single piece of bar at a time.

At the end we conclude that the conventional Power Hacksaw Machine have low efficiency, low accuracy and takes more time per unit. So by doing necessary changes and incorporating devices like limit switch, feeder and stoppers will increase efficiency and idle time per unit.

Bill Of Materials

SI	COMPONENTS	COST (Rs)	QUANTITY
1.	Electric Motor (1 Phase)	1100	1
2.	Pulley And Belt	200	1
3.	Plywood	60	1
4.	Bolts, Nuts and washers	235	25
5.	Steel Pipe (1m)	750	2
6.	Connecting rod (1m)	300	2
7.	Square Tube (2m)	800	5
8.	Hacksaw	225	2
9.	Vise	300	2
10.	Springs	30	2
11.	Labour Cost	3000	
	TOTAL	7000	43

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