

# Fabrication of Automated Four-Way Hack Saw Machine by using Scotch Yoke Mechanism

Vydyam Nagaraja, M. Rajesh



**Abstract:** Now days, increasing productivity is the main requirements in production engineering. This is possible by either reducing the operation time or by improving the efficiency of the machine. In the mass production, work pieces are machined simultaneously without any ideal time. This machine operates four hack saws simultaneously at the identical time. In this project the human effort is reduced by automating the hack saw machine, which performs less and easier operations of cutting the wood, metals and plastic materials. In This current research, a scotch yoke (Slotted link) mechanism is used to convert rotary motion of the pulley into the reciprocating motion of the hack saw frame to get the desired cutting action. Additionally, by keeping the Rheostat to the motor, the speed of hack saw frame is controlled according to the type of the work piece, and also the hack saw frame can be attached or removed when the work center is in ideal. Hence, by the four way hacksaw machine, the production rate can be increased and cost of labor also minimized.

**Key words:** AC motor, scotch-yoke mechanism, Rheostat, hacksaw, production

So it is impossible to depend upon Traditional single frame electrically operated hacksaw machines and need the enhancement in technology and design of such machines. With the help of this four-way hacksaw machine the four metal bars can be cut concurrently at high speed and, to obtain mass production for most income in associated companies. So that, this machine overcomes all the boundaries and drawbacks of conventional hacksaw machines, it is also helpful for small scale industries due to its simple working and running conditions along with its compatibility, effectively and less costly price. These machines are exact to the point that they can cut metal with least time made up of various materials however that those can perform single activity of machining at once.

## I. INTRODUCTION

A hacksaw is a handheld apparatus used to cut the materials like plastic, tubing and metal funnels. A hacksaw consists of a metal frame that resembles a downward-facing with a handle of plastic or wood or metal is normally attached to one finish of the edge. Hacksaw edges are long and slim portions of solidified steel, that element a column of teeth along their front position. Each finish of the cutting edge is punched with a little gap that fits onto the saw casing fasteners. Most sharp edges extend long from ten to 12inches (25.4 to 30.48 cm), although six-inch (15.24 cm) edges can be acquired to fit littler hacksaw models. This machine applies the force and changes the direction of a force, in order to perform a task, generally involving work done on a load. Machines are regularly intended to yield a high mechanical bit of scope to reduce the labor expected to do that work. In current situation many electrically operated power hacksaw machines of distinctive businesses, with unique specs are available for the use in shop floor. These machines are so unique that they can cut metallic bars with minimal time made up of one of a kind materials but they have one and most important advantage that those are in a position to cut single piece of bar at a time. For industries to attain the mass production, it is necessary to machine metal bars with excessive rate.

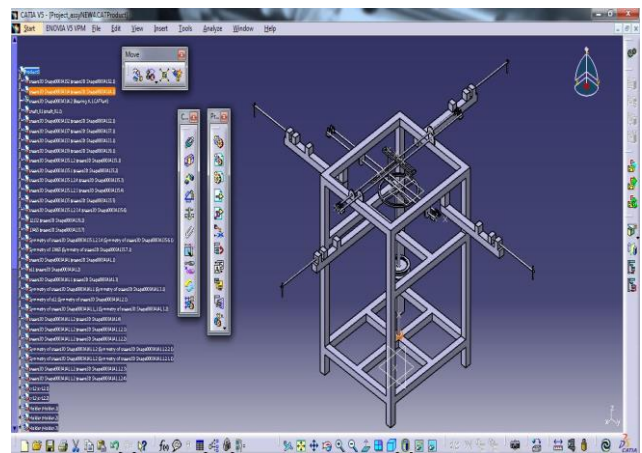


Fig. Proposed CAD model of Four Way Hacksaw Machine

## II. PROBLEM DEFINATION

The fabrication & development of FOUR-WAY HACKSAW MACHINE is, a structure which is designed for the purpose of simultaneous cutting of work pieces i.e. Four work pieces concurrently to do cutting of different materials with higher production rates and improvement in accuracy, efficiency on account of minimization of machine idle time. As the machine overcomes all the limitations and drawbacks of conventional hacksaw machine, it is helpful for small scale industries. It can operate in four different directions at same time; this model will be helpful in all kinds of limitation of traditional hacksaw machine.

## III. METHODOLOGY

In this project the power supply is provided to the motor and the power is transmitted to the ventured pulley which is connected to the shaft by the belt drive.

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Toward one side of the shaft is associated with bearing, opposite end is being joined to a roundabout circular disc, through this round plate scotch yoke system is being performed (rotatory movement is changed over to reciprocating movement) and the slotted links are attached to the pin of the disc of scotch yoke mechanism and the four hacksaws are attached to the slotted links perpendicular to each other. The single stage induction AC electric motor inflexibly set at the edge of the base casing. A ventured pulley is arranged to the shaft which is put at the center of the base edge and a plate and scotch yoke mechanism conceived to the shaft. Furthermore, two slotted connections are put on the plate at opposite to one another. The two hacksaws are fitted for each the slotted connection to get the ideal cutting activity and the methodology of the project is explained below fig.

- Scotch yoke mechanism
- AC Motor
- Control of hacksaw speed by Rheostat

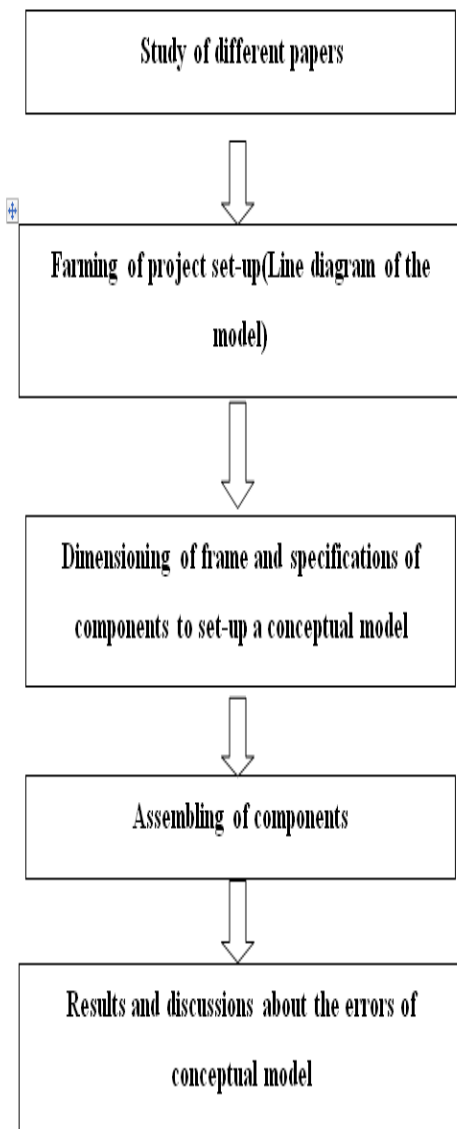
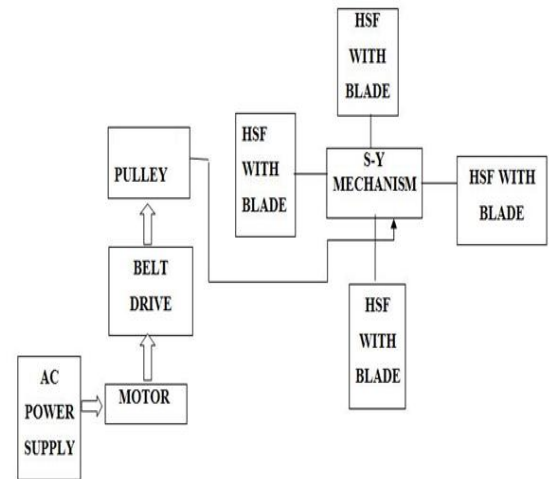


Fig. Methodology of the project

## IV. COMPONENTS ARRANGEMENT



HSF=HACKSAW FRAME  
S-Y=SCOTCH YOKE MECHANISM  
Fig. Block Diagram of the Model

## V. SCOTCH YOKE MECHANISM

The scotch yoke mechanism is built with iron bars. Here the crank is made with some length and the yoke is additionally made by utilizing a similar material. It is noticed that the base length of the yoke have to be two fold the length of the crank. The crank and yoke is associated with a rod. Iron bars are welded to the two sides of the yoke to get the responding movement. The yoke with the iron bars is fixed on the main frame with the assistance of c clamp. Now the crank is welded to the end of the shaft. Presently the stick on the crank is associated with the yoke. This mechanism is utilized for changing over turning movement into reciprocating movement. Iron bars are welded to the two sides of the yoke to get the responding movement. The yoke with the iron bars is fixed on the base frame with the assistance of square pipe that is somewhat greater than that of the iron bars. Presently the crank is associated through a slotted link mechanism. Presently the pin on the crank is associated with the yoke.

### Working principle:

At the point when the power is provided to the motor, shaft and crank joined to the pin begin turning. As the crank turns the stick slides inside the yoke and further more pushes the yoke ahead. At the point when the crank turns the forward way, the most extreme relocation will be equivalent to the length of the crank, at the point when the crank finishes the following of revolution the yoke returns to its underlying position. For the following of revolution, yoke moves the progressive way. At the point when the crank finishes a full revolution the yoke moves back to the underlying position. For a total pivot of crank the yoke travels through a length equivalent to twofold the length of the crank. The removal of the yoke can be constrained by changing the length of the crank.

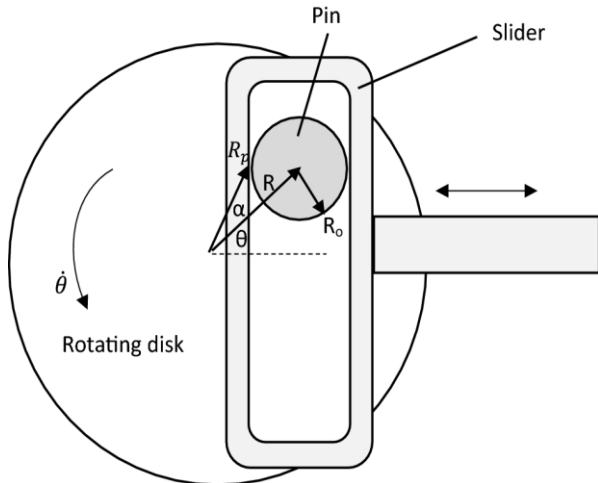


Fig. Scotch Yoke Mechanism

VI. COMPONENTS OF THE PROJECT

- Base frame
- AC motor
- Pulleys
- Belt drive
- shaft
- Bearings
- Disc with a pivot rod
- Slotted links
- Connecting rods
- Vices
- Hacksaw frames with blades
- Rheostat

VII. BASE FRAME

The base frame is the one of the main component in this project. This frame supports the remaining all components of the project. The base frame is made up of mild steel bars and the rectangular mild steel bars are cut according to the required dimensions and The frame dimensions are of 2x2x3.5 ft. The base frame fabricated by means of arc welding. The rectangular tube bars are cut according to the dimensions which had discussed above and by the accurate alignment the bars are welded. Then the supporting structures are welded at the middle of the base frame. The leveling of the base frame is checked by means of spirit level.



Fig. Base frame

VIII. AC MOTOR

This project uses an AC induction motor to rotate the shaft. An AC motor is an electric motor driven by a substitute flow (AC). The AC motor usually comprises of two fundamental parts, an outside stator having coils provided with exchanging current to deliver a turning attractive field, and an inside rotor appended to the yield shaft creating a second pivoting attractive field. The rotor attractive field might be delivered by changeless magnets, hesitance saliency, or DC or AC electrical windings. The ac motor consists of mainly two parts one is stator and another is rotor. The stator is kept at the outside of the field which produces the magnetic field and the rotor is kept inside the field to produce the magnetic flux. This project use AC motor with specifications of voltage of 230V, 2A and a speed of 1350 RPM. The AC motor is arranged to the base frame at the one corner. The shaft is driven by the ac motor by means of belt drive.



Fig. Motor

IX. PULLEY

A pulley is a wheel on axle or shaft that is used to support movement and to change the direction of a tight link or belt or for transmitting the power between the shaft and belt. On the account of a pulley supported by a frame that does not transmit power to the shaft. The supportive shell is known as square and the pulley might be known as sheave. A pulley may have a groove or grooves between flanges around its boundary to find the link or belt. The drive element of a pulley system can be a rope, link, belt, V-belt pulleys are completely utilized for transmitting power between two parallel axels. The most notable distinction between a v-belt pulley and different sorts of pulleys (round belt, flat, and so on.) would be the geometry of the groove or grooves situated around the periphery of the pulley; these grooves guide and increase footing on a v-belt. The going with video offers a comprehensive diagram of some v-belt nuts and bolts, just as their favorable merits and varieties. This project uses two pulleys one is for motor shaft and another is for main shaft. The diameter of the main shaft pulley are inner diameter is 22mm and the outer is up to 140 mm

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Fig. Motor pulley

Fig. Shaft Pulley

## X. SHAFT

Shaft is a common machine member which is used to transmit the power from one element to another element in the form of rotary motion. Generally it has circular cross section and it can be in solid or hallow. The design of shaft can be depending up on the shaft material. For the free rotation of the shaft it is supported by the bearings to transmit the power without friction or bending. The shaft is made of different materials.

- Alloy steels
- Mild steels
- Stainless steels

This project uses stainless steel shaft to transmit the power. The stainless steel shaft consist some excellent properties like good corrosive resistance, excellent resistance to stress rust cracking.



Fig. Shaft

## XI. BELT DRIVE

Belt is closed or looped material which is used to transmit the power from the motor shaft or other to the other element. The belt will transmit the power between the driver pulley to the driven pulley. the belts may be in made up of different materials. V-Belts are resistance based power or torque transmitting devices. The power is transmit from one pulley to the other by means of the friction between the belt and pulley.

- Balata
- Rubber
- composite

This project uses rubber belt to transmit the power between the motor pulley to the shaft pulley. The rubber used as the base material acts as a very important function in this. The size of the belt are in different categories of A, B, C, D, E. They are segregated according to the capacity of power transmitting of the belt. In this project we use A30 size belt to transmit the power.

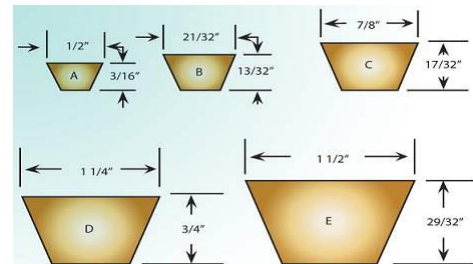
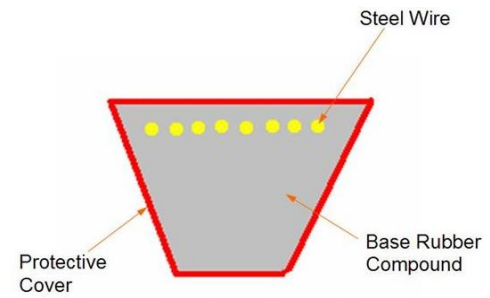


Fig. Construction features of belt

## XII. BEARINGS

A bearing is device part that constrains the comparative motion to only the desired motion, and reduces roughness between moving parts. Bearings can classify generally according to the type of operation, the motion allowed, or to the directions of the loads applied to the elements. In this project we use oil sealed ball bearing to rotate the shaft smoothly. In this project two bearings are used to support the shaft, one is at the bottom of the shaft and another one is at the middle of the shaft. The ball bearings are in different sizes, in this project we use 22\*50\*14 mm.



Fig. Bearings

## XIII. DISC AND THE PIVOT ROD

The Disc is the one of the main component in the four way hacksaw machine. The disc is made up of iron. The disc is made by the forging method by bending the narrow rod for the diameter of 250mm. and that forged rod is welded at, which two ends of the rod are contacting together. For that ring two strips of rectangular plates are welded perpendicular to each other.

The disc is joined to the top end of the shaft. Disc is joined by means of welding process. While the pivot rod is a small rod is placed at a corner of the disc to accommodate the slotted links. The pivot rod plays a vital role in this machine. The pivot rod is inserted inside of the slotted links when the disc rotates it guides the slotted links to move forward and backward movements. The pivoted rod is of height of 60mm.



Fig. Disc with pivot rod

#### Slotted links with connecting rods

The slotted links are made of iron rods to make a moment of hacksaw frames. The slotted links are prepared by welding process by joining the iron rods in rectangular shape. In this project we use two slotted links which are perpendicular to each other. The connecting rods are welded at the two sides (per side two connecting rods) of the slotted links. The connecting rods of length of 450 mm which are made of iron rods of diameter of 10 mm.



Fig. slotted link with connecting rod

#### Rheostat

Rheostat is a variable resisting device which is used to control the speed of the motor by physically expanding or diminishing the obstruction. The English researcher Sir Charles Wheatstone authored the word rheostat, it is gotten from the Greek word "rheos" and "- stasis" which means a stream controlling device and flow controlling instrument. Rheostat decreases the electric flow stream to certain level. In any case, it doesn't totally obstruct the electric flow stream. To totally block the electric flow stream, we need unbounded opposition. For all intents and purposes it is beyond the not possible to totally obstruct the electric flow. The rheostat may be in different types but this project uses the variable rheostat. The variable rheostat is used to control the speed of the motor by varying. In variable rheostat there are many types which are segregated according to the value of resistance. In this project 115Ω rheostat is used. The resistance can be calculated by the Ohm's law.

$$\text{i.e. } V=IR, R=V/I$$

Where V= Voltage  
I= Current  
R= Resistance



Fig. Rheostat

#### XIV. PROCEDURE FOR CONSTRUCTION OF MACHINE

##### 1. Preparation of Main Frame

The main frame is made of mild steel bars. The base frame is made by the size of 2 ft. length & width of 2 ft. & with the height of 3 ft. The base frame fabricated by means of arc welding. The rectangular tube bars are cut according the dimensions which had discussed above and by the accurate alignment the bars are welded. Then the supporting structures are welded at the middle of the main frame. The leveling of the base frame is checked by means of spirit level.

##### 2. Joining the Bearings to the Bottom Support of the Main Frame

In this project two ball bearings are used to rotate the shaft, one is at the bottom support of the main frame and another one is at the middle support of the main frame. The bearings are joined by means of arc welding by providing small supports to the bearing sides. Care should be taken while welding otherwise it leads to the oil leakage from the bearing and it may not be work.

##### 3. Assembling the Shaft to the Main Frame

After joining the bearings the shaft is fitted into the bearings, before inserting the diameter of the shaft is measured. If the diameter is bigger than the bearing diameter then the shaft diameter is reduced by the turning operation, then again measured this is done by trial and error method. The shaft must rotate freely with the bearings. The shaft is made up of cast iron. The height of the shaft must be lesser than that of main frame height.

##### 4. Inserting Pulley into The Shaft

After insertion of the shaft into the bearings, further the pulley has to insert into shaft. Before inserting the diameter of the pulley is measured by means of vernier calipers.

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If the diameter is small, then the diameter of the hole is extended by the turning operation using conventional lathe machine. So that the pulley can be insert freely into the shaft. If the diameter is larger than the shaft diameter then a bolt is tightened at the side of the pulley to the shaft so that it cannot be move from the shaft. The height of the pulley must be equally placed to the height of the motor. The height of the pulley can vary by means of bolt which is placed at the side of the pulley.

## 5. Preparation of Slotted Link Mechanism

The slotted link mechanism consists of crank with pivot rod, slotted link and connecting rods. In this mechanism the connecting rods are attached to the slotted links to host the hack saw frame. And the slotted links are in the rectangular shape, for the each side of the slotted link is attached by the two connecting rods. The pivot rod is placed on the crank at the one corner end and it is in between the slot of the slotted link to guide the connecting rods. In this project two slotted links are used and these are placed perpendicular to each other on the pivot rod. When the crank (Disc) rotates the pivot rod guides the slotted links to move the connecting rods forward and backward motions. When the pivot rod reaches to the maximum diameter of the Disc then the **hacksaw frame1** moves forward and **hacksaw frame2** moves backward and for the remaining hacksaw frames follows the same principle.

## 6. Joining of Vices to the Base frame

Vice is a mechanical apparatus used to hold an object to allow work to be performed on it. Vices have two parallel jaws, one fixed and the movable, threaded in and out by a screw and lever. Vices are of various types, as a metalworking vice or fitter vice, is used to clamp work piece. It is typically made of cast steel or malleable cast iron. This project uses four vices to hold work pieces. These vices are welded to the base frames which are perpendicular to each other

## XV. WORKING

When the power of 220 V and 2A is supplied to the single phase AC induction motor, then the motor rotates with the speed of 1350 RPM. Then the shaft rotates in clock wise direction because the shaft is connected with the belt drive to the motor and pulley (which is inserted to the shaft). When the shaft rotates the disc rotates so that the pivot rod starts rotating because the pivot rod is assembled on the top of the disc. When the pivot rod is starts rotating the slotted link mechanism also will starts working. When the pivot rod is at the peak diameter of the disc (which is opposite side to the hacksaw1) then the hacksaw1 and hacksaw 3 will move in the retractive direction and the remaining hacksaws 2&4 will move in the extractive direction so that the cutting action will takes places. When the pivot rod is at the Peak diameter of the disc (which is opposite side of the hacksaw2) then the hacksaw2 will move in the retractive direction and hacksaw1 will move in extractive direction and the cutting action will takes place. And the process is repeated until the cutting of work piece has completed. When the work center is ideal the hacksaw frame also can be disengaged from the holders of the connecting rods, then the speed of the hacksaw frame is controlled by means of rheostat according the type of work piece which has to cut. The rheostat is connected to the motor by sliding the lever the speed of the motor is controlled.

## XVI. ADVANTAGES

- Low cost and easy maintainance
- It saves human effort.
- It is safe for cutting operation.
- Increase efficiency.
- Time saves due to Simultaneous cutting of work pieces

## XVII. DISADVANTAGES

- ❖ It will stop if one hacksaw frame faces a problem.
- ❖ Whole four operation stop due to one problem

## XVIII. COSTING

S.No.	Particulars	Total quantity	Cost Rs/unit	Total cost(Rs)
1	AC Motor	1	3500	3500
2	Ball bearings	2	150	300
3	Circular rods	4	50	200
4	Pulley	2	100	200
5	Cast iron shaft	4 Kg	80	320
6	Circular disc	1 Kg	40	40
9	Bolt and nuts	20	10	200
10	V-type belt	1	100	100
11	Iron Bars	2 ½ length	600	1500
15	Electric cable	1 Q/10m	50	50
17	Rheostat	1	700	700
18	Hack saw frames	4	110	440
19	Welding works	-	-	3000
18	Other parts machining Cost	-	600	600
19	Transportation and Miscellaneous	-	1700	1700
TOTAL				12850/-

## XIX. CONCLUSION

The four-way hacksaw machine is a simply designed and low cost machine, which can reduce the human effort by automating the hacksaw by using scotch yoke mechanism. This four way hacksaw machine can replace by the conventional hacksaw machine due to the higher productivity and less time consuming. The productivity plays a major role in the firms, when the productivity increases then the profits also get increased. So the four way hacksaw machine can cut the four work pieces simultaneously at the same time due to the consisting of four work centers. By the four way hacksaw machine the man power can be reduced and labor cost is also gets minimized.

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