A PROJECT REPORT ON

# "DEVELOPMENT OF MECHANISM FOR NOTCH CUTTING ON CIRCULAR OBJECTS"

SUBMITTED TO

**ANJUMAN-I-ISLAM'S KALSEKAR TECHNICAL CAMPUS**

SUBMITTED BY

**IJAZAHMED DANDEKAR**

**ADNAN DONGARKAR**

**SAIF MAHIMKAR**

**MUSHARAF SHEIKH**

IN PARTIAL FULFILMENT FOR THE AWARD OF THE DEGREE OF

## BACHELOR OF ENGINEERING

IN

## MECHANICAL ENGINEERING

UNDER THE GUIDANCE

OF

**PROF. ASIF GANDHI**

**DEPARTMENT OF MECHANICAL ENGINEERING**

**ANJUMAN-I-ISLAM'S**

**KALSEKAR TECHNICAL CAMPUS, NEW PANVEL**

**NAVI MUMBAI -410206**

**UNIVERSITY OF MUMBAI**

**ACADEMIC YEAR 2017-2018**

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL

**(Approved by AICTE, recg. By Maharashtra Govt. DTE,**

**Affiliated to Mumbai University)**

PLOT #2&3, SECTOR 16, NEAR THANA NAKA, KHANDAGAON, NEW PANVEL,NAVI MUMBAI-410206, Tel.: +91 22 27481247/48 * Website: www.aiktc.org

## APPROVAL OF DISSERTATION

This is to certify that the thesis entitled

**"DEVELOPMENT OF MECHANISM FOR NOTCH CUTTING ON CIRCULAR OBJECTS"**

Submitted by

**IJAZAHMED DANDEKAR**

**ADNAN DONGARKAR**

**SAIF MAHIMKAR**

**MUSHARAF SHEIKH**

In partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering, as prescribed by University of Mumbai approved.

**(Internal Examiner)** **(External Examiner)**

Prof. Asif Gandhi ________________

DATE:___________

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL

**(Approved by AICTE, recg. By Maharashtra Govt. DTE,**

**Affiliated to Mumbai University)**

PLOT #2&3, SECTOR 16, NEAR THANA NAKA, KHANDAGAON, NEW PANVEL,NAVI MUMBAI-410206, Tel.: +91 22 27481247/48 * Website: www.aiktc.org

# *CERTIFICATE*

This is to certify that the project entitled

## "DEVELOPMENT OF MECHANISM FOR NOTCH CUTTING ON CIRCULAR OBJECTS"

Submitted by

**IJAZAHMED DANDEKAR**

**ADNAN DONGARKAR**

**SAIF MAHIMKAR**

**MUSHARAF SHEIKH**

To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

| | |
|---|---|
| **Internal Examinar** | **External Examiner** |
| Prof. ASIF GANDHI | Prof. |
| **Head of Department** | **Principal** |
| Prof. **ZAKIR ANSARI** | **DR.ABDUL RAZZAKHOUNTAGI** |

# ACKNOWLEDGEMENT

On completion of this project work, we would like to express our sincere thanks to all those who has helped us to reach our goal. It's a great pleasure and moment of immense satisfaction for us to express my profound gratitude to our guide **Prof. Asif Gandhi** whose constant encouragement enabled us to work enthusiastically. His perpetual motivation, patience and excellent expertise in discussion during progress of the project work have benefited us to an extent, which is beyond expression.

We would also like to give our sincere thanks to **Prof. Zakir Ansari**, Head of the Department, **Prof. Prof. Asif Gandhi** Project Guide and **Prof. Shaikh Rizwan**, Project Co-ordinator from department of Mechanical Engineering, Kalsekar Technical Campus, New Panvel , for their guidance, encouragement and support during the project.

We are thankful to **Dr. Abdul Hountagi**, Kalsekar Technical Campus, New Panvel, for providing an outstanding academic environment, also for providing the adequate facilities.

Last but not the least I would also like to thank all the staffs of Kalsekar Technical Campus (Mechanical Engineering Department) for their valuable suggestions brightened us.

**IJAZAHMED DANDEKAR**
**ADNAN DONGARKAR**
**SAIF MAHIMKAR**
**MUSHARAF SHEIKH**

# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# ABSTRACT

The machine we will design and fabricate is used for cutting the end of the tubes so that it fits against another shape for welding. This project gives details about the notching mechanism used for generating profile on the tubes.

According to the type of material to cut and thickness of the job, the cutting speed and electric arc generation can be changed. Notching on pipes/ Tubes is main process for welding of two circular components perpendicular to each other.

In our project "Development of mechanism for notch cutting on circular objects", the AC motor is connected to the shaft with the help of pulley. The Arc cutting torch is connected to the cam and follower mechanism for giving motion as per desired profile. The machine is portable and easy in transportation.

# CHAPTER 1

# INTRODUCTION

# 1.1 Introduction

Tube notching is most often performed before joining tubes together to make a T or similar joint. Either one or both tubes may be notched before being welded together. End notching is the process of forming a cut on the end of a tube to create a shape that will mate to an existing tube. Side notching (offset notching) is the process of cutting an opening into the side of a tube to create a V notch for bending or a V notch for a T joint. **Notching** is a metal-cutting process used on sheetmetal or thin barstock, sometimes on angle sections or tube. A shearing or punching process is used in a press, so as to cut vertically down and perpendicular to the surface, working from the edge of a workpiece. Sometimes the goal is merely the notch itself, but usually this is a precursor to some other process: such as bending a corner in sheet or joining two tubes at a tee joint, notching one to fit closely to the other.

Notching is a low-cost process, particularly for its low tooling costs with a small range of standard punches. The capital cost of the punch press In this 21st century, notching of tubes is generally carried out process.A very essential tool for every manufacturer who uses tubes to his constructions is the notchers. The notchers are very useful as they are used to remove a piece of the tube in order to fit precisely on another tube without leaving any gap between them and so that their welding to be accurate. Generally, notchers are essential tools and particularly, in constructions like a buggy, exhaust, fields of a mini football and in anything that requires the use of tubes and the procedure of welding.These are majorly done in fabrication industry.

can be expensive though, so small fabrication shops often out-source their notching work to a press shop or notching specialist. Notching of large or heavy sections, particularly for large tube fabrication or HVAC, is increasingly carried out by plasma cutting rather than punch tools.The accuracy of punch notching is good, depending on the care with which it's carried out. For manual folding work, prior notching can often improve resultant accuracy of the folding itself.The speed of notching is usually limited by manual handling when loading the workpieces into the press. Pieces some feet long may be manually loaded into a single-stroke press. Smaller pieces are still generally hand-fed, limiting speeds to perhaps 100 strokes / minute.

There are various kinds of notcher at the market and each and every one has its own advantages and disadvantages. In particular, our construction uses the electrode are cutter as a cutting tool.

Fabricators use notching for applications as varied as bicycle frames, automobile components,aerospace parts, and household piping systems. Notching takes many forms and shapes. The equipment and process needed depend on the notch shape, the raw material, and manufacturing considerations such as tolerance and production rate.There are many machines &equipments to carry out tube notching operation but more cost &presious time is involved in such machines. So to overcome this major setback we have here Designed a cam operated mechanism for notch cutting using electrode arc.

## 1.2 Types of notchers

Tube and pipe can be notched with a variety of tools and machines, from saws to plasma cutters. For the hobbyist, the job shop, and the manufacturer, the most common machine tools used for making weld joints are the hole saw, the abrasive-belt notcher, and the end mill notcher.

### 1.2.1 The Hole Saw

Using a hole saw is an inexpensive way to make the occasional notch for a weld joint. More for the hobbyist, hole saws can be used with a drill press or, for portability, with a hand-held drill.

Multiple corresponding hole saws must be used to make notches with different ODs. Hole saws provide a less-than-perfect finish, and they are not the best solution for repeatability or large numbers of notches. Thin-walled tube is difficult to notch with a hole saw without creating a deformation, and the saws usually have a limited range of OD sizes. With that said, those on a budget who make the occasional notch are usually satisfied with the results.

FIG 1.1

### 1.2.2 Abrasive-belt Notcher

Several manufacturers make these notchers that have similar functionality. Abrasive notchers use an abrasive belt to sand or grind the metal to the desired weld joint size. For each separate OD, a mandrel sized to correspond with that OD is inserted to the point where the abrasive belt wraps and the notching takes place (see **Figure 1**).

FIG 1.2

Linear screw feeds or faster feed levers position and feed the material into the mandrel and belt. Quick-change mandrels allow fast changeover times, and bearingless mandrels, which have bearings built into the machine, allow the fastest changeover times. Fixed-mandrel machines are more labor-intensive to change.

Additional features, such as a grinding station or a sanding station, make the abrasive notcher popular. The separate grinding station should be used with a reversible motor to keep the belt direction moving in a downward position for safety.

Additionally, operators should wear personal protective equipment when using notchers and grinders because of the dust, sparks, and high heat they generate. Some manufacturers offer dust collection units as an option with this type of machine. Sparks can be a hazard so it is important to use the abrasive notcher in an area free of flammable goods.

### 1.2.3 End Mill Notcher

One version of this type of notcher has a stationary end mill that is sized according to the OD to make the proper weld jointWith this notcher, the material is fed into the cutter either straight on or at an angle.

Another version is an eccentric-cut notcher that uses one cutter to notch sizes from 1 to 3 in. OD without tooling changes. This is done by setting an indicator to coincide with the desired weld joint OD that adjusts a cam on which the cutter rotates. The operator turns the handwheel, causing the cutter to move into the material to be notched in an eccentric orbit that cuts out the weld joint for the desired size (see **Figure 2**).

End mill-style machines generally can be used to produce notches on material with wall thicknesses of 0.065 in. or more. They do not produce heat, dust, or sparks. Non-eccentric-cut end mill notchers need different tooling for each size, increasing costs. These cutters can last longer and can be resharpened up to three times. Cutters can also be sourced locally.

FIG 1.3

## 1.3 Problem Statement

A manufacturer who produces repetitive products (Ex. Bicycle manufacturer produces bicycle frame repeatedly, hand railing manufacturer produces hand railing repetitively etc) these manufacturers does not require very expensive & bulky machines to do their work. The machines which are now available in the market for generating profile on the tubes are very bulky &these machine requires skill operators to operates the machines and proper adjustment of angle is necessary to generate required profile.

For a notch cutting process first the notch cut has to be analyse in the software. After analysing the cut has to be processed under 1:1 ratio .This notch also depends on the requirement of the product, such that all notch are not of similar shape & size. There are various machines &equipments used for notch cutting but they include more money input as the machines used are big in size & have high maintenance.

## 1.4 Aim

In response to the above problems, the need for the design of the cam mechanism for easy & essential notch cutting is proposed. Cam mechanism is introduced such that notches of various size& shapes can be easily performed. The setup thus reduces the capital input & at the same time increases production accuracy.

## 1.5 Objective

- To reduce the human effort & the labour work to cut the profile on tubes & save time.
- To .increase the production rate.
- To reduce the cost of automation.
- To create a portable machine which is easy to handle.

## 1.6 Conclusion

In the beginning of this chapter, an overview of the design layout planning and its importance to the system is written further to enhance the importance for using it as the main principle for this project. The objectives are also defined to be linked to the deliverables in this case study. The boundary of this project is also defined based on the statement of problem. Some justifications of conducting this case study and its importance is also discussed.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Summary of work done for researches

The whole and sole objective of the project is to develop and design a cam mechanism for the automatic cutting of the tubes to get perfect notches as per the requirement.

Our wide range of tube and pipe cutting machines includes machines that can handle small or large diameter tubes and that can be equipped with power hacksaw. We supply pipe cutting machines for round, elliptic or conical pipes as well as fully automated equipment featuring integrated logistics, or simpler, mobile versions. Pipe cutting machines are popular in offshore, pipe processing, ship building, pressure vessel, structural and mechanical contracting manufacturing because of the complex cuts and profiles typical required in their respective industries. Pipe cutting, or pipe profiling, is a mechanized industrial process that removes material from pipe or tube to create a desired profile. Typical profiles include straight cuts, mitres, saddles and midsection holes.

### 2.1.1 Turning Roll & Conveyor Assembly-

machines consist of a rigid structural steel frame on which two parallel shafts with turning rolls are mounted. The shafts are driven by a variable-speed DC motor through two minimum backlash worm gearboxes. Heavy-duty roller and thrust bearings ensure smooth rotation of the main shafts and pipe. The pipe is self-centering and fully supported by turning rolls located along the entire length of the machine bed. Various models accommodate a wide range of pipe diameters, so only the cutting torch is raised or lowered to accommodate different diameters. The standard machine is capable of conveying and rotating a single random (20-22 foot) length of pipe. An optional machine extension provides full rotation and support for double random lengths up to 44’ long. Extensions are identical in construction to the standard machine bed and connect to the main drive shafts, lifter-conveyor frame, and straight cut-off carriage track of the base machine.

FIG 2.1

### 2.1.2 Two-Torch Straight Cut-off Assembly

The 2-torch straight cut-off assembly produces pipe spools to length with straight and beveled end cuts. Two torches make cuts simultaneously, one on the trailing end of the first piece and one on the leading edge of the second piece. The operator moves the rolling torch carriage to the proper distance on the machine, locks it into positions according to a tape measure mounted on the machine frame, and conveys the pipes against a retractable pipe stop. While cutting is performed, steel wheels mounted next to the torches maintain a constant tip-to-pipe distance.

FIG 2.2

### 2.1.3 Computerized Profiling Assemblies

Microprocessor technology puts production-line productivity at your fingertips to quickly and accurately process all types of pipe profiles and holes. Computer-controls synchronize torch movement, burning and pipe handling functions, and maintenance diagnostics. PLC technology coordinates auxiliary machines functions like torch on-off and automatic out-of-round compensation. Rugged construction using minimum-backlash worm drives, machined & hardened ways and precision rack & pinion drives ensure repeatability and longevity. Mechanized movement is controlled by DC servo motors with encoder feedback.

FIG 2.3

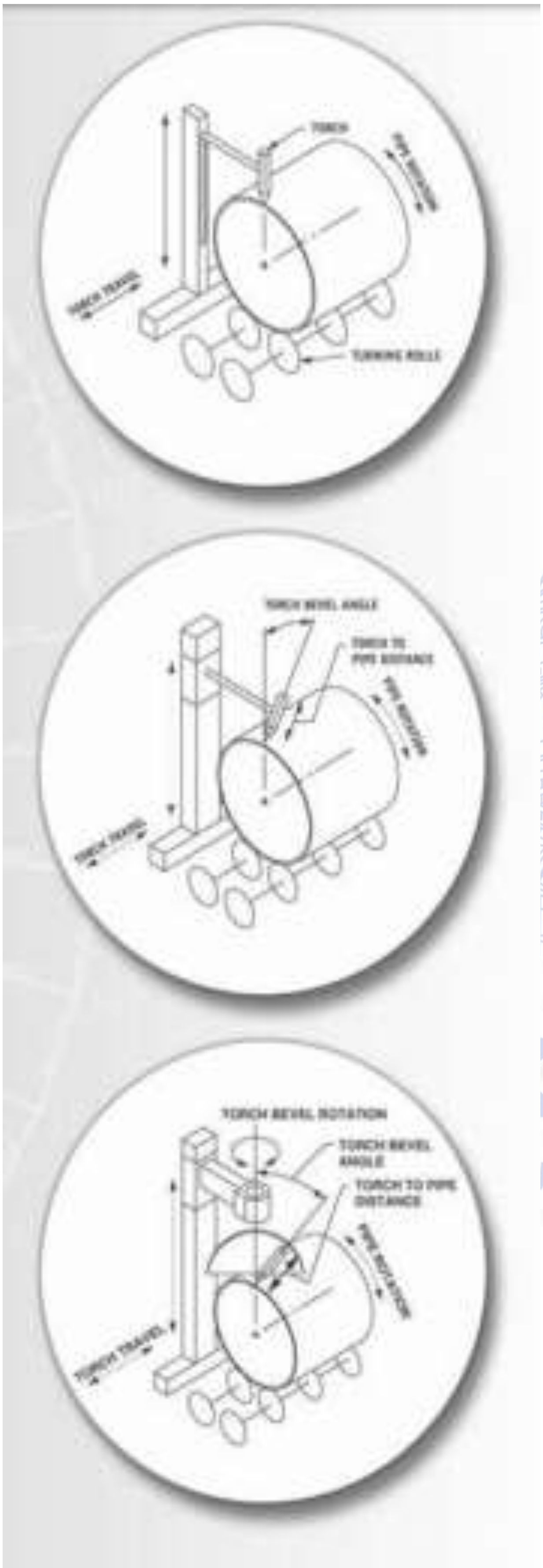



FIG 2.4

**MPM-2**

The 2-axis control, Model MPM-2, employs a simple processor to coordinate pipe rotation with longitudinal torch movement. The torch remains at a fixed bevel angle so the included weld preparation angle between members varies throughout the connection. Profile cutting is performed on the front end of the machine bed. Height adjustment is controlled from the operator’s console.

**MPM-4**

The 4-axis control, Model MPM-4, incorporates four axes of motion to orient the torch to the proper weld preparation angle and to maintain the proper torch-tip-topipe distance. This produces a constant included weld prep angle between the adjoining pieces. The computer control compensates length measurement regardless of weld prep angle. Automatic out-of-round compensation is accomplished by analog proximity sensors on an independent closedloop servo circuit. The cutting carriage and operator’s

**MPM-5**

The 5-axis control, Model MPM-5, adds an additional axis of motion to rotate the torch bevel angle so that it remains normal to the contour cut path. To produce a constant weld prep angle, the machine can burn any desired bevel angle at any location on the pipe. The principal benefits of this assembly are slightly faster cutting speeds and very accurate weld preparation angles common in offshore construction and pressure vessel fabrication.

**2.2 PanditMandarBipinchandra, PathanArfatSherkhan, KasarPawanPrakash, GajbharKunalPrakash, Vishal P.chaudhari** - Automatic pipe cutting machine has used for mass production and aim at reducing the human involvement in order to increase the productivity and accuracy of the product. Automatic pneumatic pipe cutting machine uses a pneumatic circuit for cutting of pipes which, ultimately reduces the total time required for the complete cutting operation and increases the production rate.

FIG 2.5

**NimbalkarShripad, VelanjeSagar, PatilAbhay, VarpePooja** has conducted invention relates to pneumatically operated automatic pipe-cutting machine. The arrangement of the pneumatic valves deployed in this system is accordance to the circuit planned. The choice of cutter is based on the stress calculated bearing in mind the pipe or rod material. The material favoured in this system is a pipe for demo. But mild steel rods and pipes can also be worked out by using diverse cutter provisions.

# CHAPTER 3

# METHODOLOGY

## 3.1 3D Cad Model

In response to the above problems, the need for the design of the cam mechanism for easy & essential notch cutting is proposed. Cam mechanism is introduced such that notches of various

size& shapes can be easily performed. The setup thus reduces the capital input & at the same time increases production accuracy. Therefore, the design of the model in autodesk inventor.
Inventor Autodesk was used in order to convey the design clearly and accurately.

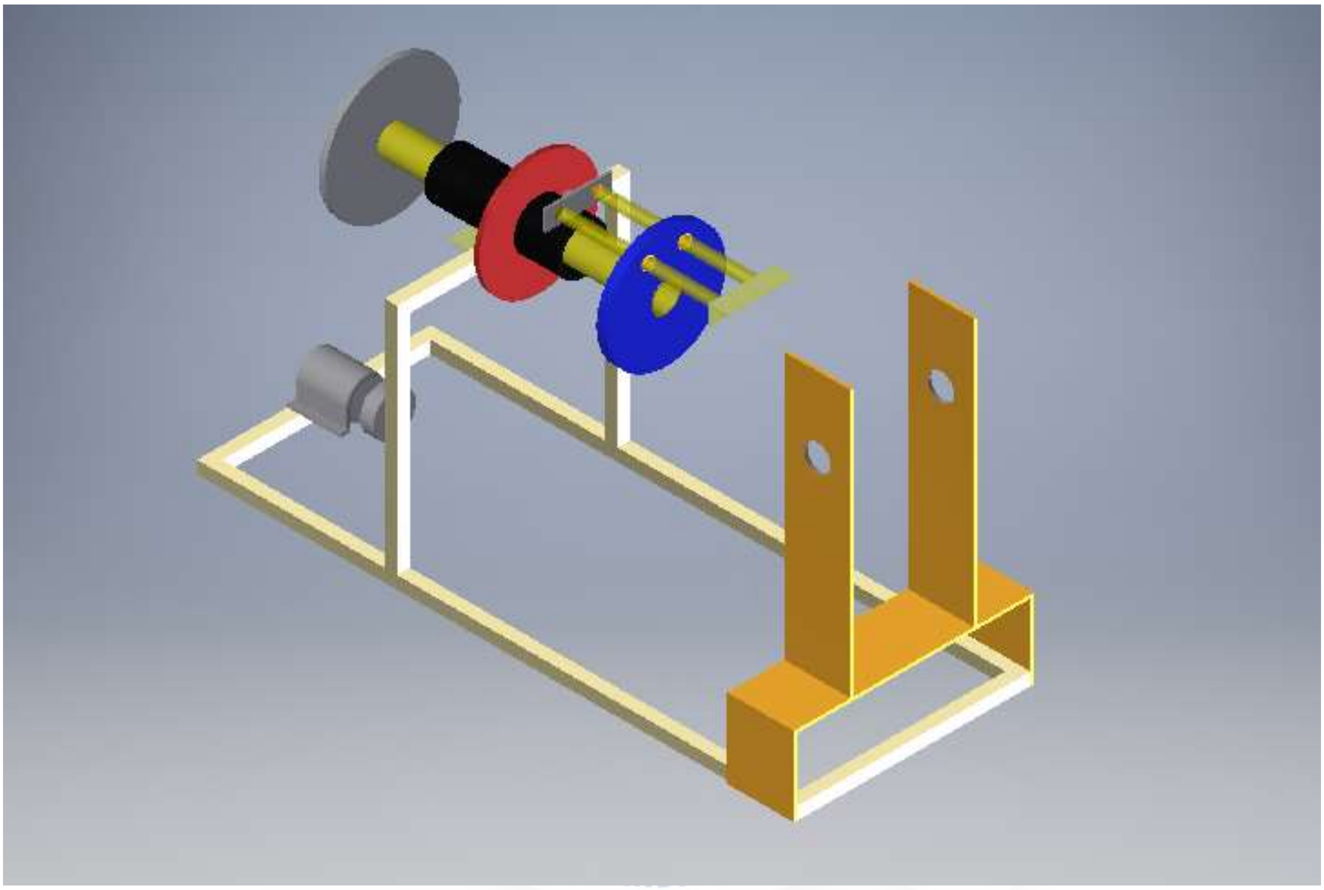


FIG 3.1

The soft start features allow for use of less current on start up providing more flexibility in plant alignments when electrical power is limited as well as extending the life of motors. The cad model was made on inventor Autodesk.

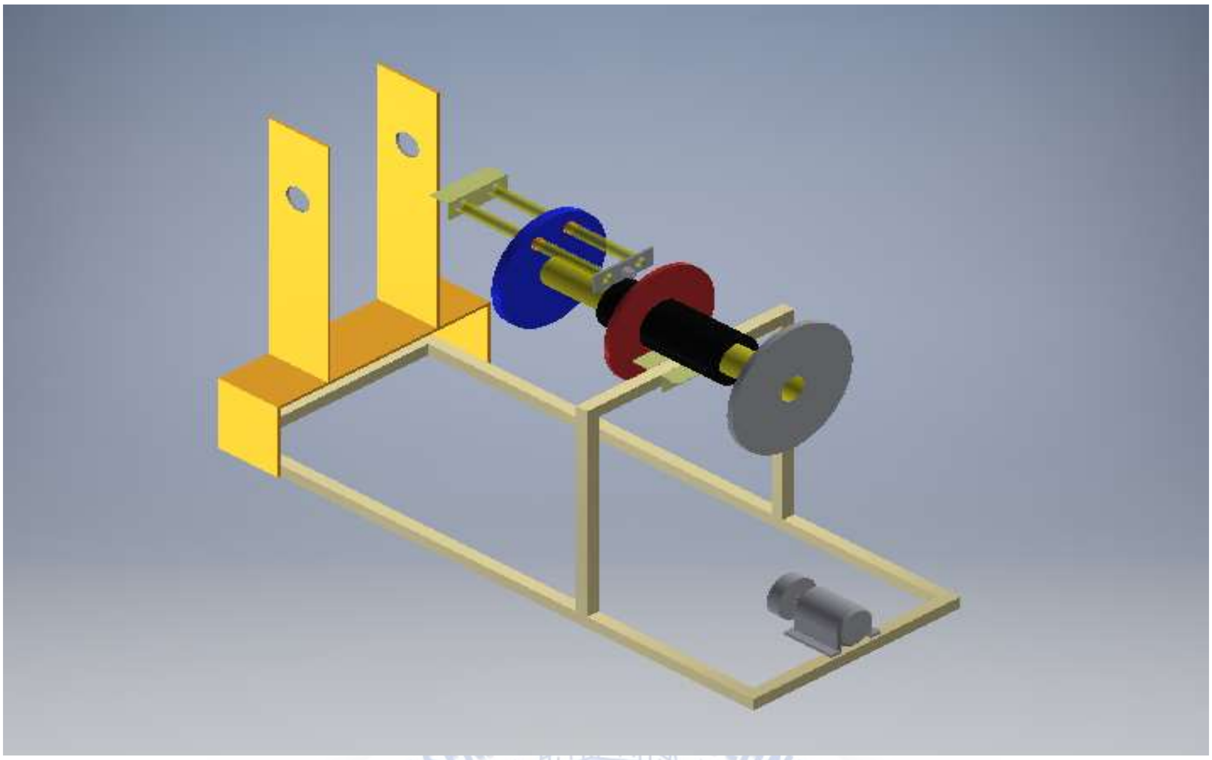


FIG 3.2

## 3.2 Design of frame

The frame is the most important part of the model since all the load has to be placed on the frame including the motor, the bearing and the shaft. The frame dimensions are 900 x 350 x 430 (all the dimensions being in mm). The cad model is as shown below.

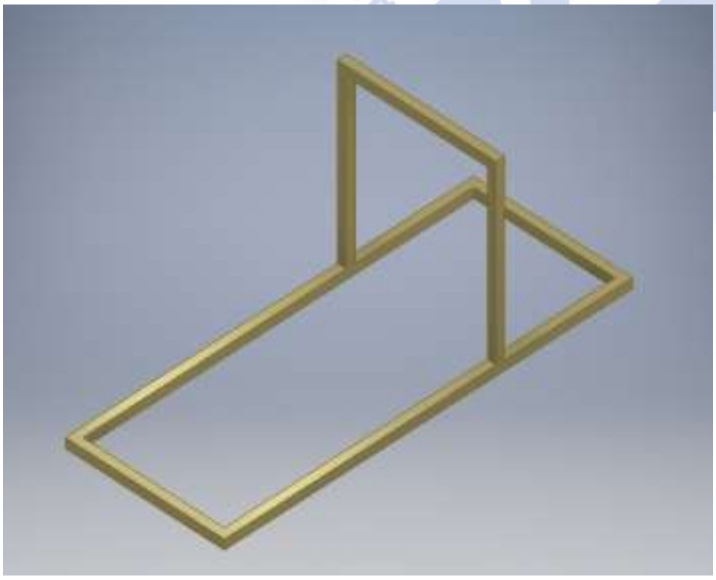


FIG 3.3

FIG 3.4

## 3.3 Motor & Pulley

Initially, we used a motor taken by car wipers but then we preferred an DC motor having the potential of moving both on the right and on the left. The motor was connected with a potentiometer to regulate the speed of its rotation and with a switch that chooses the rotational direction as well as the activation of the motor. Therefore, by activating the motor the perforated shaft rotates on the direction that we want and at the speed that we wish. After we had achieved our goal and this function, we put an aluminum flange lined with linear bearing at the front side of the perforated shaft. The linear bearing is used for ensuring a forward and backward move in our machine.

FIG 3.5

FIG 3.6

### 3.3.1 A.C and D.C Motors

**Advantages of DC motors:**

- **Speed control over a wide range both above and below the rated speed:** The attractive feature of the dc motor is that it offers the wide range of speed control both above and below the rated speeds. This can be achieved in dc shunt motors by methods such as armature control method and field control method. This is one of the main applications in which dc motors are widely used in fine speed applications such as in rolling mills and in paper mills.
- **High starting torque:** dc series motors are termed as best suited drives for electrical traction applications used for driving heavy loads in starting conditions. DC series motors will have a staring torque as high as 500% compared to normal operating torque. Therefore dc series motors are used in the applications such as in electric trains and cranes.

- **Accurate steep less speed with constant torque:** Constant torque drives is one such the drives will have motor shaft torque constant over a given speed range. In such drives shaft power varies with speed.
- Quick starting, stopping, reversing and acceleration
- Free from harmonics, reactive power consumption and many factors which makes dc motors more advantageous compared to ac induction motors.

**Disadvantages of DC motors:**

- High initial cost
- Increased operation and maintenance cost due to presence of commutator and brush gear
- Cannot operate in explosive and hazard conditions due to sparking occur at brush ( risk in commutation failure)

## 3.4 Cam Mechanism

- Depending upon the diameter of tube of pipe on which profilehas to be generated,the cam is designed.In cam the designed angle of notch & depth is been taken into account.If the diameter of the pipe changes a 90 degree,an adjustable arm depends on the changes in diameter.The roller follower traces the path of cam & develops the required profile.The roller is designed in such a way that it adjusts itself on the edges. There is a spring attached in the adjustable arm so that it gets a forward & backward motion .This mechanism basically works on the profilic design, so as we design the profile for cam, the cam will follow that part & cut that desired notch. Notch cutting for some materials take a dig as some materials have different cutting properties as Hardness,Toughness etc. Notch wear at the cut line is also a serious problem during the matching of high-austenitic stainless steels.We always take care for the cutting process as the wear condition doesn't just eradicate but surely is reduced with increased efficiency. The critical point where the finished notch seems to be related to factors such as transverse stress & temperature distribution & chemical interaction. Thus the progress of notch has often been the localised shear region of the chip & the exposed binder phase of the tool.

FIG 3.6

### 3.5 Conclusions

From the analysis, It has been noted that the speed of the wiper motor used at first was not much & then we preffered an A.C motor & obtained better results.

This is further justified when its continuosly noted for some time for better accuracy & optimum results.

We conclude the following problems :

- Motor speed & shaft rotation.
- Cam mechanism & its efficient working.

# CHAPTER 4

# MATERIAL SELECTION

The proper selection of material for the different part of a machine is the main objective in the fabrication of machine. For a design engineer it is must that he be familiar with the effect, which the manufacturing process and heat treatment have on the properties of materials. The Choice of material for engineering purposes depends upon the following factors:

Availability of the materials.

Suitability of materials for the working condition in service.

The cost of materials.

Physical and chemical properties of material.

## 4.1 Mechanical properties of material

The mechanical properties of the metals are those, which are associated with the ability of the material to resist mechanical forces and load. We shall now discuss these properties as follows:

1. Strength: It is the ability of a material to resist the externally applied forces.

2. Stress: Without breaking or yielding. The internal resistance offered by a part to an externally applied force is called stress.

3. Stiffness: It is the ability of material to resist deformation under stresses. The modules of elasticity of the measure of stiffness.

4. Elasticity: It is the property of a material to regain its original shape after deformation when the external forces are removed. This property is desirable for material used in tools and machines. It may be noted that steel is more elastic than rubber.

5. Plasticity: It is the property of a material, which retain the deformation produced under load permanently. This property of material is necessary for forging, in stamping images on coins and in ornamental work.

6. Ductility: It is the property of a material enabling it to be drawn into wire with the application of a tensile force. A ductile material must be both strong and plastic. The ductility is usually measured by the terms, percentage elongation and percent reduction in
area. The ductile materials commonly used in engineering practice are mild steel, copper, aluminum, nickel, zinc, tin and lead.

7. Brittleness: It is the property of material opposite to ductile. It is the
property of breaking of a material with little permanent distortion. Brittle materials when subjected to tensile loads snap off without giving any sensible elongation. Cast iron is a brittle material.

8. Malleability: It is a special case of ductility, which permits material to be rolled or hammered into thin sheets, a malleable material should be plastic but it is not essential to be so strong. The malleable materials commonly used in engineering practice are lead, soft steel, wrought iron, copper and aluminum.

9. Toughness: It is the property of a material to resist the fracture due to high impact loads like hammer blows. The toughness of the material decreases when it is heated. It is measured by the amount of absorbed after being stressed up to the point of fracture. This property is desirable in parts subjected to shock an impact loads.

10. Resilience: It is the property of a material to absorb energy and to resist rock and impact loads. It is measured by amount of energy absorbed per unit volume within elastic limit. This property is essential for spring material.

11. Creep: When a part is subjected to a constant stress at high temperature for long period of time, it will undergo a slow and permanent deformation called creep. This property is considered in designing internal combustion engines, boilers and turbines.

12. Hardness: It is a very important property of the metals and has a wide variety

Of meanings. It embraces many different properties such as resistance to wear scratching, deformation and machinability etc. It also means the ability of the metal to cut another metal. The hardness is usually expressed in numbers, which are dependent on the method of making the test. The hardness of a metal may be determined by the following test.

a) Brinell hardness test

b) Rockwell hardness test

c) Vickers hardness (also called diamond pyramid) test and

d) Share scaleroscope.

## 4.2 Selection Criteria of the material

The science of the metal is a specialized and although it overflows in to realms of knowledge it tends to shut away from the general reader. The knowledge of materials and their properties is of great significance for a design engineer. The machine elements should be made of such a material which has properties suitable for the conditions of operations. In addition to this a design engineer must be familiar with the manufacturing processes and the heat treatments have on the properties of the materials. In designing the various part of the machine it is necessary to know how the material will function in service. For this certain characteristics or mechanical properties mostly used in mechanical engineering practice are commonly determined from standard tensile tests. In engineering practice, the machine parts are subjected to various forces, which may be due to either one or more of the following.

1. Energy transmitted
2. Weight of machine
3. Frictional resistance
4. Inertia of reciprocating parts
5. Change of temperature
6. Lack of balance of moving parts

The selection of the materials depends upon the various types of stresses that are set up during operation. The material selected should with stand it. Another criteria for selection of metal depend upon the type of load because a machine part resist load more easily than a live load and live load more easily than a shock load.

Selection of the material depends upon factor of safety, which in turn depends upon the following factors.

1. Reliabilities of properties
2. Reliability of applied load
3. The certainty as to exact mode of failure
4. The extent of simplifying assumptions
5. The extent of localized
6. The extent of initial stresses set up during manufacturing
7. The extent loss of life if failure occurs
8. The extent of loss of property if failure occurs

## 4.3 Materials selected in fabrication of the model

### 4.3.1 Mild Steel

Base plate, motor support, sleeve and shaft , cam

Reasons:

1. Mild steel is readily available in market
2. It is economical to use
3. It is available in standard sizes
4. It has good mechanical properties i.e. it is easily machinable

5. It has high tensile strength

6. Low co-efficient of thermal expansion

Properties of Mild Steel:

- M.S. has a carbon content from 0.15% to 0.30%.
- They are easily wieldable thus can be hardened only.
- Both ultimate tensile and compressive strength of these steel increases with increasing carbon content.
- They can be easily gas welded or electric or arc welded.
- With increase in the carbon percentage weld ability decreases.

### 4.3.2 Aluminium

**Pulley**
Reasons:
1. To reduce the weight on the shaft
2. Aluminium is readily available in market
3. Available at cheaper cost

Properties of Aluminium:
1. Light in weight
**2.** High Tensile strength

FIG 4.1

### 4.3.3 Rubber:

**Belt**
Reasons:
1. Light in weight
2. Available at cheaper cost
3. Readily available in market

FIG 4.2

## 4.4 Selection Of Bearing

A **bearing** is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may *prevent* a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

Rotary bearings hold rotating components such as shafts or axles within mechanical systems, and transfer axial and radial loads from the source of the load to the structure supporting it. The simplest form of bearing, the *plain bearing*, consists of a shaft rotating in a hole. Lubrication is often used to reduce friction. In the *ball bearing* and *roller bearing*, to prevent sliding friction, rolling elements such as rollers or balls with a circular cross-section are located between the races or journals of the bearing assembly. A wide variety of bearing designs exists to allow the demands of the application to be correctly met for maximum efficiency, reliability, durability and performance.

### 4.4.1 **Bearing Materials**

The bearing rings and rolling elements of rolling bearings are subjected to repetitive high pressure with a small amount of sliding. The cages are subjected to tension and compression and sliding contact with the rolling elements and either or both of the bearing rings.

Therefore, the materials used for the rings, rolling elements, and cages require the following characteristics:

Primarily, high carbon chromium bearing steel (Table 13.1) is used for the bearing rings and rolling elements. Most NSK bearings are made of SUJ2 among the JIS steel types listed in Table 13.1, while the larger bearings generally use SUJ3. The chemical composition of SUJ2 is approximately the same as AISI 52100 specified in the USA, DIN 100 Cr6 in Germany, and BS 535A99 in England.

Table 4.1 Chemical Composition of High-Carbon Chromium Bearing Steel (Major Elements)

| Standard | Symbols | Chemical Composition (%) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | C | Si | Mn | P | S | Cr | Mo |
| JIS G 4805 | SUJ 2 | 0.95 to 1.10 | 0.15 to 0.35 | Less than 0.50 | Less than 0.025 | Less than 0.025 | 1.30 to 1.60 | — |
| | SUJ 3 | 0.95 to 1.10 | 0.40 to 0.70 | 0.90 to 1.15 | Less than 0.025 | Less than 0.025 | 0.90 to 1.20 | — |
| | SUJ 4 | 0.95 to 1.10 | 0.15 to 0.35 | Less than 0.50 | Less than 0.025 | Less than 0.025 | 1.30 to 1.60 | 0.10 to 0.25 |
| ASTM A 295 | 52100 | 0.93 to 1.05 | 0.15 to 0.35 | 0.25 to 0.45 | Less than 0.025 | Less than 0.015 | 1.35 to 1.60 | Less than 0.10 |

For bearings that are subjected to very severe shock loads, carburized low-carbon alloy steels such as chrome steel, chrome molybdenum steel, nickel chrome molybdenum steel, etc. are often used. Such steels, when they are carburized to the proper depth and have sufficient surface hardness, are more shock resistant than normal, through-hardened bearing steels because of the softer energy-absorbing core. The chemical composition of common carburized bearing steels is listed in Table 13.2.

NSK uses highly pure vacuum-degassed bearing steel containing a minimum of oxygen, nitrogen, and hydrogen compound impurities. The rolling fatigue life of bearings has been remarkably improved using this material combined with theappropriate heat treatment. For special purpose bearings, high temperature bearing steel, which has superior heat resistance, and stainless steel having good corrosion resistance may be used. The chemical composition of these special materials are given in Tables 13.3 and 13.4.

Table 4. 2 Chemical Composition of Carburizing Bearing Steels (Major Elements)

| Standard | Symbols | Chemical Composition (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | C | Si | Mn | P | S | Ni | Cr | Mo |
| JIS G 4052 | SCr 420 H | 0.17 to 0.23 | 0.15 to 0.35 | 0.55 to 0.95 | Less than 0.030 | Less than 0.030 | Less than 0.25 | 0.85 to 1.25 | — |
| | SCM 420 H | 0.17 to 0.23 | 0.15 to 0.35 | 0.55 to 0.95 | Less than 0.030 | Less than 0.030 | Less than 0.25 | 0.85 to 1.25 | 0.15 to 0.35 |
| | SNCM 220 H | 0.17 to 0.23 | 0.15 to 0.35 | 0.60 to 0.95 | Less than 0.030 | Less than 0.030 | 0.35 to 0.75 | 0.35 to 0.65 | 0.15 to 0.30 |
| JIS G 4053 | SNCM 420 H | 0.17 to 0.23 | 0.15 to 0.35 | 0.40 to 0.70 | Less than 0.030 | Less than 0.030 | 1.55 to 2.00 | 0.35 to 0.65 | 0.15 to 0.30 |
| | SNCM 815 | 0.12 to 0.18 | 0.15 to 0.35 | 0.30 to 0.60 | Less than 0.030 | Less than 0.030 | 4.00 to 4.50 | 0.70 to 1.00 | 0.15 to 0.30 |
| ASTM A 534 | 8620 H | 0.17 to 0.23 | 0.15 to 0.35 | 0.60 to 0.95 | Less than 0.025 | Less than 0.015 | 0.35 to 0.75 | 0.35 to 0.65 | 0.15 to 0.25 |
| | 4320 H | 0.17 to 0.23 | 0.15 to 0.35 | 0.40 to 0.70 | Less than 0.025 | Less than 0.015 | 1.55 to 2.00 | 0.35 to 0.65 | 0.20 to 0.30 |
| | 9310 H | 0.07 to | 0.15 to | 0.40 to | | | 2.95 to | 1.00 to | 0.08 to |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 0.13 | 0.35 | 0.70 | Less than 0.025 | Less than 0.015 | 3.55 | 1.40 | 0.15 |

## 4.5 Selection of cutting process

Arc Cutting Process . Carbon Arc Cutting:

In carbon arc cutting, carbon or graphite electrode is used to melt the metal to achieve a cut as shown in Fig. 19.11. Graphite electrodes permit higher current densities, remain sharp for longer time and produce a neater cut than carbon electrodes. Direct current power source is used with the electrode connected to the negative side of the circuit. Table 19.3 gives an approximate estimate of the rate of cutting steel plate with graphite electrodes.

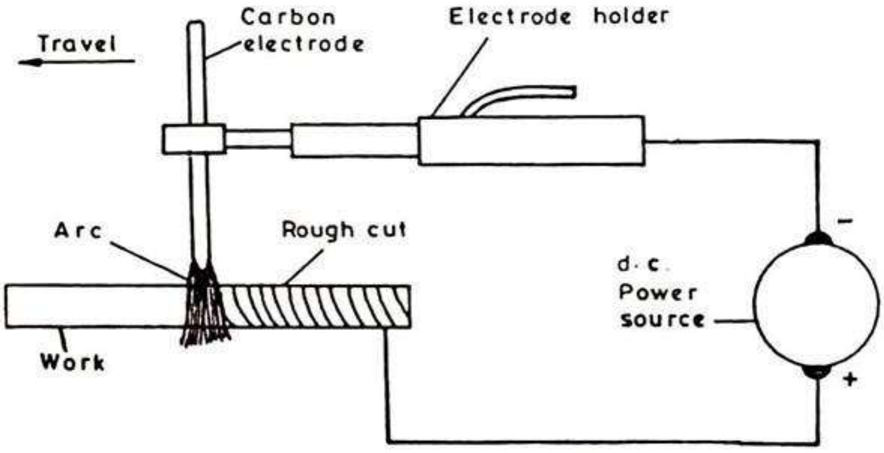



FIG 4.3

**Table 19·3 Current Settings for Graphite Electrode Cutting of Steel Plate**

| *Plate thickness (mm)* | *Electrode diameter (mm)* | *Current (A)* | *Cutting rate (m/hr)* |
|---|---|---|---|
| 6 | 10 | 400 | 21·00 |
| 10 | 10 | 400 | 18·00 |
| 16 | 10 | 400 | 10·50 |
| 25 | 15 | 600 | 4·80 |
| 50 | 15 | 600 | 2·70 |
| 75 | 15 | 600 | 1·80 |
| 100 | 15 | 600 | 1·00 |
| 200 | 20 | 800 | 0·45 |
| 300 | 20 | 800 | 0·24 |

TABLE 4.3

The position best suited for arc cutting is downhand or vertical-up to permit the molten metal to flow readily out of the cut. The resultant kerf is usually rough with fused edges. The roughness of kerf is attributed to jumping of arc from one side to another. Other drawbacks of carbon arc cutting are a broad cut upto 25 mm wide, a low rate of cutting on heavy sections, appreciable carbon pick up by the kerf causing increased hardness and therefore subsequent machining difficulties and high current requirement. Carbon arc cutting can be used for product cutting of cast iron, alloy steels and non-ferrous metals; however this process does not have much industrial significance.

**Arc Cutting Process . Air Carbon Arc Cutting:**

The air carbon arc method of cutting metals consists of melting the metal with an electric arc and removing it by a blast of air. A high velocity jet travelling parallel to the carbon electrode strikes the molten metal pool just behind the arc and blows the molten metal out. Fig. 19.12 shows the basic features of the process. The carbon electrode is held in a specially designed holder containing holes through which jets of compressed air blow along and behind the electrode.

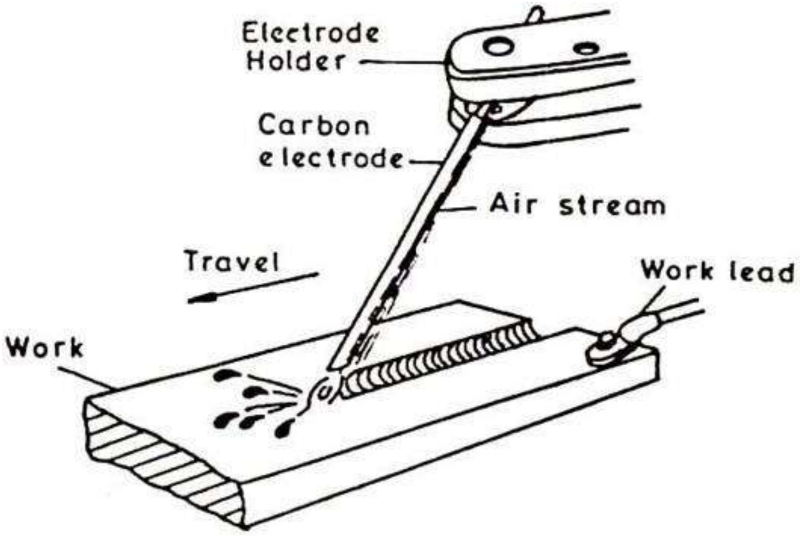



FIG 4.4

**Arc Cutting Process 3. Metal Arc Cutting:**

In metal arc cutting process the cut is achieved by arc melting between an electrode and the workpiece; the molten material is removed by the force of gravity. When covered electrodes are used for cutting, the process is called shielded metal arc (SMA) cutting. The equipment required is the standard shielded metal arc welding equipment. In SMA cutting the core material may be any low carbon steel, even that unsuitable for welding, because impurities in the core metal are of little consequence. Preference should be given for deep penetration coatings like cellulosic coating. A relatively small diameter electrode should be used with d.c. electrode negative.

The coating slows down the melting of the electrode, stabilises the arc and acts as an insulator preventing the arc from shorting with the side wall as the electrode is fed into the cut. If the electrode coating is made wet by dipping in water the electrode consumption rate will come down so that more length can be cut per electrode.

In SMA culling the current is set much higher than normally used for welding. This results in a big molten pool which falls away making the cut. On thick material a sawing action is required to make the cut and to allow the molten metal fall away as shown in Fig. 19.14.

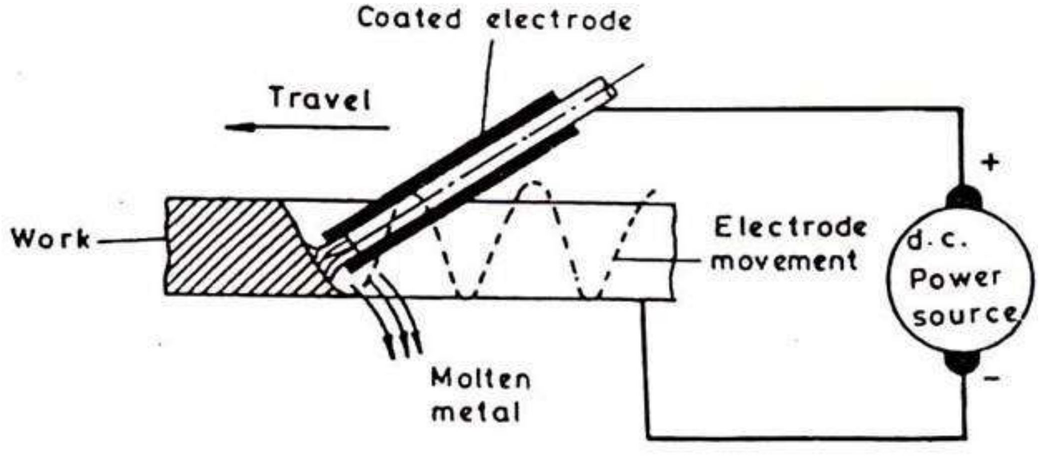



FIG 4.5

The cut produced by SMA cutting is rough but superior to carbon arc cutting; the cut is narrow with a width approximately equal to electrode diameter. It is used mostly for rough work such as cutting up scrap, rivet cutting and hole piercing.

**Arc Cutting Process 4. Gas Metal Arc (GMA) Cutting:**

In this process the usual gas metal arc welding equipment is used and the heat for cutting is obtained from the electric arc formed between a continuously fed electrode wire and the workpiece, usually with inert gas shielding. Arc is produced between the forward side of the wire and the advancing kerf edge. The force due to the flow of shielding gas and the electrode magnetic effects eject the molten metal from the kerf. This process can be used in all position cutting but it has hardly any industrial significance.

**Arc Cutting Process 5. Gas Tungsten Arc (GTA) Cutting:**

In this process cutting is achieved by an arc between a tungsten electrode and the work using the same equipment as used for gas tungsten arc welding (GTAW). Cutting is accomplished by raising the current density above that required for good welding conditions and with increased flow rate of the shielding gas. The velocity of the gas jet blows away the molten metal to form the kerf. A shielding gas mixture of 65% argon and 35% hydrogen is generally used. Nitrogen may be used provided adequate precautions are taken to remove the toxic fumes formed during the operation.

Typical speeds for GTA cutting are 1 to 1.5 m/min on 3 mm thick aluminium and 0-5 to 1 m/min on 3 mm thick stainless steel. The current used is 200 lo 600 A to cut stainless steel and aluminium upto 13 mm thick. The quality of cut along the kerf is good and often does not require subsequent finishing operation. This process can be used to cut stainless steels upto about 50 mm thick. The thicker the metal to be cut greater is the tolerance that must be allowed on the cut width. Although GTA cutting process can be used to cut any metal in thin sections but it has been replaced by plasma arc cutting and is now of little industrial significance except when equipment for other more efficient processes is not available.

**Arc Cutting Process 6. Plasma Arc Cutting:**

In plasma arc cutting (PAC) process the metal is cut by melting a localized area with the constricted arc and removing the molten material with a high velocity hot ionised gas called plasma jet.The plasma jet cutting is similar to keyhole mode of plasma welding except that unlike welding the keyhole is not allowed to close behind the plasma arc. The plasma jet velocity is very high thus ejection of molten metal is easy.

The plasma arc cutting is used mainly in transferred arc mode employing a pilot arc for plasma arc initiation.There are three major variations of the PAC process viz., high current plasma cutting, low current plasma cutting, and plasma cutting with water injection or water shielding. The plasma torch design depends upon the process variation.

**Table 19·6 Parameter Selection for Plasma Cutting of Aluminium**

| *Plate thickness (mm)* | *Cutting speed (m/min)* | *Orifice diameter (mm)* | *Current DCEN (A)* | *Power (KW)* |
|---|---|---|---|---|
| 6 | 7·5 | 3 | 300 | 60 |
| 13 | 5·0 | 3 | 350 | 70 |
| 25 | 2·25 | 4 | 400 | 80 |
| 50 | 0·5 | 4 | 400 | 80 |
| 75 | 0·4 | 5 | 450 | 90 |
| 100 | 0·3 | 5 | 450 | 90 |
| 150 | 0·2 | 6 | 750 | 170 |

**Note :** Plasma gas flow rate varies with plate thickness and orifice diameter, and ranges between 50 lit/min and 120 lit/min. Gases used are nitrogen and argon with hydrogen addition from 0 to 35%.

TABLE 4.4

**Table 19·7 Parameter Selection for Plasma Cutting of Stainless Steels**

| *Plate thickness (mm)* | *Cutting speed (m/min)* | *Orifice diameter (mm)* | *Current DCEN (A)* | *Power (KW)* |
|---|---|---|---|---|
| 6 | 5·0 | 3 | 300 | 60 |
| 13 | 2·5 | 3 | 300 | 60 |
| 25 | 1·25 | 4 | 400 | 80 |
| 50 | 0·5 | 5 | 500 | 100 |
| 75 | 0·4 | 5 | 500 | 100 |
| 100 | 0·2 | 5 | 500 | 100 |

**Note** : Plasma gas flow rate depends upon orifice diameter and plate thickness and ranges between 50 – 95 lit/min. The gases used are nitrogen and argon with hydrogen addition from 0 to 35%.

TABLE 4.5

**Table 19·8 Parameter Selection for Plasma Cutting of Low Carbon Steels**

| *Plate thickness (mm)* | *Cutting speed (m/min)* | *Orifice diameter (mm)* | *Current DCEN (A)* | *Power (KW)* |
|---|---|---|---|---|
| 6 | 5·0 | 3 | 275 | 55 |
| 13 | 2·5 | 3 | 275 | 55 |
| 25 | 1·2 | 4 | 425 | 85 |
| 50 | 0·6 | 5 | 550 | 110 |

**Note** : Plasma gas flow rate varies with plate thickness and orifice diameter and ranges between 95 – 140 lit/min. The gases used are compressed air, nitrogen, with upto 10% hydrogen addition. For dual flow nitrogen is used with oxygen added downstream of the electrode.

TABLE 4.6

# CHAPTER 5
# DESIGN OPERATION & CALCULATION

## 5.1 Operation

In our setup as the motor is started,due to rotation of the shaft the flange attached to the holder rotates & it rotates according to cam profile required for the notch.There are also linear bearing which helps in forward & backward movement,using these bearings, we managed to make a basis for the electrode arc cutter.In specific, our system is known as a ‘pantograph’.So thus the electrode arc cutter is spinning around the tube following the pantograph and removing the material that should be removed.It should be noted that without the pantograph, our machine cuts in a straight line and if it is needed to cut in an angle, the inclination for cutting is chosen according to the direction of clamp’s rotation. Moreover, using these bearings, we managed to make a basis for the plasma cutter. At the back side of the basis, there is a bearing that follows a guiding ring to achieve a particular move according to the guiding ring.

FIG 5.1

In specific, our system is known as a ‘pantograph’. At the front side of our machine, it was made a basis that a clamp was placed for the tubes. In this way, the plasma cutter is spinning around the tube following the orders of the pantograph and removing the material that should be removed.It should be noted that without the pantograph, our machine cuts in a straight line and if it is needed to cut in an angle, the inclination for cutting is chosen according to the direction of clamp’s rotation.

Typical shapes include fish mouth and compound fish mouth tube ends that help allow a tube end to fit tightly to another tube side.With this type of tube end forming you can assemble the tube by using a tube connector or welding the two tubes together.Another method of creating the notch is to use a special grinding tool that uses a sanding belt and grinds the tube to the proper shape. Other style of notching include cutting a V – shape out of a square tube so that the two tube sections can fold up to a 45 degree or 90 degree angle, or special notch and slot combinations can be created for unique applications.


FIG 5.3

FIG 5.2

## 5.2 Design calculations

### 5.2.1 Motor Calculation

The motor is the prime driver in our machine and it converts electrical power in to mechanical power. It gives rotary motion to mechanism. The motor design is very important design aspect in machine design practice.

We are taking car wiper motor of Power 60 watt and 25 rpm

P = 2 x 3.14 x N x T / 60

19.2 = 2 x 3.14 x 25 x T/ 60

T=19.2 x 60/2x 3.142 x 25 = 22.91 N-m = 2291.56 N-mm

Motor pulley and shaft pulley diameter 64 mm & 203mm respectively

### Motor Specification

P = 2 x 3.14 x N x T / 60

Here ,.T=5Nm and N=52 rpm

| | | |
|---|---|---|
| Voltage: | 12V | |
| Test Voltage: | 13.5V | |
| Braking Torque: | 26N.m | |
| Working Torque: | 5N.m | |
| | Low | High |
| No-load Speed: | 35 rpm | 52 rpm |
| No-load Current: | 1.4A | 2.2A |
| Working Speed: | 30 rpm | 45 rpm |
| Working Current: | 4.3A | 6A |
| Noise | 50dB | 55dB |

**5.2.2 Design of V Belt**

We know that the power transmitted per belt

P = (T1-T2) x V

As we know maximum torque on shaft = Tmax = T = 2291.56 N-mm

Where,

T1 = Tension in tight side

T2 = Tension in slack side

we know that,

T1/T2 = $e^{\mu \Theta \text{ cosec}\beta}$

T1/T2 = e0.25 x 0.721cosec 20

T1 = 7.3xT2

We have,

T = (T1 – T2) x R

2291.56 = (7.3T2 – T2) X 0.064

T2 = 56.82 N

T1 = 414.78 N

So, tension in tight side = T1= 414.78 N

V = $\pi$DN/60

= 3.142 x 64 x 25/60=0.08377 m/sec =83.44 mm/sec

P = (414.78 –56.82) x 0.08377

P = 55.58.98 W (N-m/s)

Number of V-Belts (N) :-

N = Total Power Transmitted / Power Transmitted per belt

= 55.58/60

=0.9166

Say 1 belt.

So, 1 belt is sufficient for transmission of power.

## 5.2.3 CALCULATION OF LENGTH OF BELT

We know that radius of pulley on shaft

r1 = d1/2 = 203 /2 = 101.5mm

Radius of pulley on motor shaft

r2 = d2/2 = 64/2 = 32 mm

Center distance between two pulley = 326.5mm

We know length of belt

L = Π (r2+r1) + 2 x X + (r2-r1)2/x

= Π (101.5 + 32) + (2 x326.5) + (101.5– 32)2/620

L = 1072.82 mm = 42.23 inches

### 5.2.4 DESIGN OF SHAFT

We have torque of 7338.5Nmm

Motor pulley and shaft pulley diameter 64 mm and 203mm respectively.

W=3.45 kg= 34.5N

M = F x L / 4

M = 34.5x420/4=3622.5 N-mm

Te = $(M^2+T^2)^{0.5}$= $(13.1225*10^6+53.8535*10^6)^{0.5}$

= $(66.97x10^6)^{0.5}$

Te = 8159.04 N-mm

Te = $\pi$/16 x30x$d^3$

$d^3$= 8159.04 x16/$\pi$x30 = 130544.6/94.2477 = 1385.12

d = (1385.12)1/3 = 28.71 = 30 mm

But we are using 35mm shaft, therefore our shaft design is safe.

By using 35mm shaft, our shaft design is safe.

## 5.3 Design of Bearing

Two types of bearing are used in the model. The bearings used are:

- Linear bearing
- Ball bearing

### 5.3.1 Linear Bearing

Linear bearing is used on the cam and follower mechanism. By the help of this our follower move forward and backward according to our profile and the dimension of linear bearing is 19mm and bearing Number is LM10 UU.

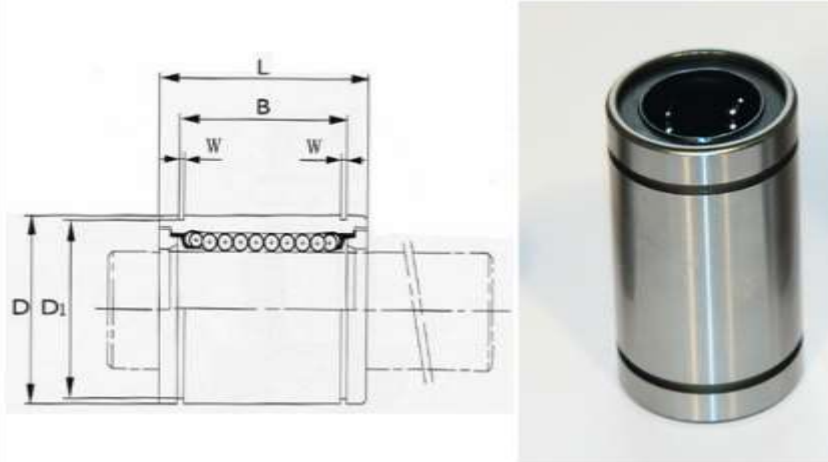



FIG 5.4

| Part Number | d | D | L | B | W | Circuits | C | Co | Weight (g) |
|---|---|---|---|---|---|---|---|---|---|
| LM 8 UU | 8 | 15 | 24 | 17.5 | 1.1 | 4 | 27 | 41 | 16 |
| LM 10 UU | 10 | 19 | 29 | 22 | 1.3 | 4 | 38 | 56 | 30 |
| LM 12 UU | 12 | 21 | 30 | 23 | 1.3 | 4 | 42 | 61 | 32 |
| LM 13 UU | 13 | 23 | 32 | 23 | 1.3 | 4 | 52 | 79 | 43 |
| LM 16 UU | 16 | 28 | 37 | 26.5 | 1.6 | 5 | 79 | 120 | 69 |
| LM 20 UU | 20 | 32 | 42 | 30.5 | 1.6 | 5 | 88 | 140 | 87 |
| LM 25 UU | 25 | 40 | 59 | 41 | 1.85 | 6 | 100 | 160 | 220 |
| LM 30 UU | 30 | 45 | 64 | 44.5 | 1.85 | 6 | 160 | 280 | 250 |
| LM 40 UU | 40 | 60 | 80 | 60.5 | 2.1 | 6 | 220 | 410 | 585 |
| LM 50 UU | 50 | 80 | 100 | 74 | 2.6 | 6 | 390 | 810 | 1580 |
| LM 60 UU | 60 | 90 | 110 | 85 | 3.15 | 6 | 480 | 1020 | 2000 |

TABLE 5.1

## 5.3.2 Ball Bearing

Ball bearing is mounted to support the shaft and transfer the rotary motion to the front flange. Ball bearing is under the base Pipe at the end and The dimension of the ball bearing is same as that of the shaft i.e. 35mm and bearing number is 6207.

P=Roller Ball bearing

Pe = Xc x Fr x S.F x kt

Xc =1.1

$Fr=W_{pulley}+(T1 + T2)/2+W_{flange}$ =382.74N

Pe= 1.3Fr = 497.56N =49.75 kgf

Lhr= 7200 hrs

Lmr = $(Lhr \times N \times 60)/10^6 = (7200 \times 25 \times 60)/10^6$ = 5.4mR

C =[Lmr] x [Pe]1/k

Therefore, C = 49.75kgf

FIG 5.5

Therefore, we use Roller Ball bearing having Bore diameter of bearing = 35 mm

Bearing number is SKF 6207

Hence safe.

# CHAPTER 6

# BILL OF MATERIALS AND FABRICATED PROTOTYPE

## 6.1 BILL OF MATERIAL

After surveying the market for purchasing the components necessary for the fabrication of the product the material were selected and purchased.

the cost can be divided into three categories as in the three below tables:

Direct purchased materials:¬

| Sr. no | components | quantity | cost |
|---|---|---|---|
| 1 | MS plates | - | 1000 |
| 2 | Aluminium Pulley | 2 | 370 |
| 3 | bearing | 4 | 360 |
| 4 | Rubber belt | 1 | 170 |
| 5 | Pipes | - | 700 |
| 6 | motor | 1 | 400 |
| 7 | Flanges | 2 | 320 |
| 8 | follower | 1 | 40 |

Table 6.1 Cost of Direct Purchased Materials

Fabricated parts

| Sr no | components | quantity | cost |
|---|---|---|---|
| 1 | frame | 1 | 550 |
| 2 | flanges | 2 | 500 |
| 3 | Cam and follower | 1 | 200 |
| 4 | MS pipe | 2 | 300 |

Table 6.2 Cost of Fabricated Materials

Labour Cost

| Sr no | process | cost |
|---|---|---|
| 1 | Surface finishing | 1100 |
| 2 | cutting | 400 |
| 3 | drilling | 300 |
|  | total | 1800 |

Table 6.3 Labour Cost

## 6.2 Fabricated prototype

Thus, after assembly of all the parts the final prototype after fabrication is as shown in the in below fig. The model has been fabricated with utmost care and taking into consideration various factors such as cost, time and the necessary force for demonstration of the principle.

FIG 6.1

FIG 6.2

FIG 6.3

# CHAPTER 7

# CONCLUSION

### 7.1 Discussion

Initially, the build was to exactly replicate the Inventor drawings. This plan was to be carried out if at all possible. Unfortunately, due to time and resource constraints, design modifications were required in order to produce a marketable project in time. As previously stated, inexperience and unfamiliarity of the user with the equipment made for a "learn as you go" environment. This meant that when road blocks in design were met, alternative methods were drafted to address the impedances. Regardless, a product was built with similar design and strength qualities and could enter the market for a competitive price

### 7.2 Recommendations

There are several recommendation that could be made for this project. First, in order to produce a more marketable and more consistent product, a permanent shop space would need to be acquired. Working on this project at two locations proved not only to take much longer, but new obstacles appeared after each move.

The last recommendation would be to gain experience in project involving tubing at smaller scale. Once comfortable working with the material type and the tooling, a project of this scale could be accomplished much more precisely and efficiently. In a manufacturing scheme, this may involve hiring someone with experience to help with the production.

### 7.3 FUTURE SCOPE

- In this case we put the workpiece manually but it get upgrade by automation feeding machine
- By using computer program we can perform all process automatically
- We can replaced Arc cutting tool by plasma cutter for better performance
- Now we set angle manually but in future angle of cutting can be set automatically

## 7.4 Conclusion

In conclusion, our construction's advantages are multiple. For example, it is mobile and light, it can cut tubes of a large diameter compared to other kinds of machines that are not capable of that. Also, it can cut straight angles and various shapes according to the guiding ring of the pantograph. More importantly, its major advantage is its cost as it is much less comparing to other machines like CNC that are also capable for the same thing. Additionally, its potentials are not just restricted to these as it is also capable to cut round flanges and many other things using different clamps and different basis for the plasma cutter.

PAPER PUBLISH

International Journal of Scientific & Engineering Research Volume 9, Issue 3, March-2018
ISSN 2229-5518 28

# Development Of Cam Mechanism For Notch Cutting By Using Electrode Arc

Mohd Musharaf Shaikh, Saif Mahimkar, Ijaz Dandekar, Adnan Dongarkar
( mush.shaikh418@gmail.com, mahimkarsaif@gmail.com, ijazahmed982@gmail.com, adnandongarkar786@gmail.com )

Department of Mechanical Engineering
Anjuman'I Islam Kalsekar Technical Campus, Affiliated By Mumbai University

**Abstract**—In some Cases,where cylindrical objects are used, some places require a proper notch so that welding at that place is perfectly done.To get a perfect notch different machines are used,in some machines, operations are done by using plasma,but here we have tried to reduce the cost of plasma cutting by using an electrode arc for the cutting/notching. Vee notches in tube, particularly square tube, may be cut so deep as to cut almost through the tube: three sides of a square tube. This then allows corner, usually finished by welding.

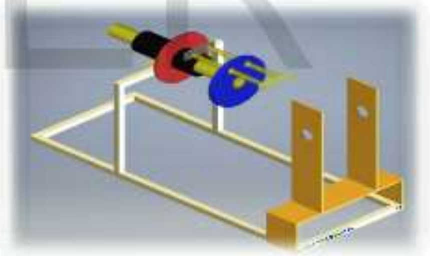
**Index Terms**— Cam mechanism;Cylindrical Objects;Electrode Arc;Notch Cutting

## Introduction

Notching is a low-cost process, particularly for its low tooling costs with a small range of standard punches.The speed of notching is usually limited by manual handling when loading the workpieces into the press. Pieces some feet long may be manually loaded into a single-stroke press. Smaller pieces are still generally hand-fed, limiting speeds to perhaps 100 strokes / minute. It is an operation of removing a small part of metal sheet of desired shape from edge of metal sheet.

## Mechanism

Depending upon the diameter of tube of pipe on which profilehas to be generated,the cam is designed.In cam the designed angle of notch & depth is been taken into account.If the diameter of the pipe changes a 90 degree,an adjustable arm depends on the changes in diameter.The roller follower traces the path of cam & develops the required profile.The roller is designed in such a way that it adjusts itself on the edges. There is a spring attached in the adjustable arm so that it gets a forward & backward motion .This mechanism basically works on the profilic design, so as we design the profile for cam, the cam will follow that part & cut that desired notch.Notch cutting for some materials take a dig as some materials have different cutting properties as Hardness,Toughness etc. Notch wear at the cut line is also a serious problem during the matching of high-austenitic stainless steels.We always take care for the cutting process as the wear condition doesnt just eradicate but surely is reduced with increased efficiency. The critical point where the finished notch seems to be related to factors such as transverse stress & temperature distribution & chemical interaction.Thus the progress of notch has often been the localised shear region of the chip & the exposed binder phase of the tool.



## Motor & Pulley

Initially,we tested using a motor from car wipers but after some test we preferred an AC motor from car wipers having the potential of moving both on right & on left.Then we connected the motor with a potentiometer to regulate the speed of its rotation & with a switch that chooses the rotation of the direction as well as the activation of the motor.So as the motor is ON the perforated shaft rotates on the direction we want & as the speed we wish. After we have achieved our goal uptill this,we put an aluminium flange lined with linear bearing at the front side of the perforated shaft.The linear bearing is used for ensuring a forward & backward move in our machine.

International Journal of Scientific & Engineering Research Volume 9, Issue 3, March-2018
ISSN 2229-5518


## Operation

In our setup as the motor is started, due to rotation of the shaft the flange attached to the holder rotates & it rotates according to cam profile required for the notch.There are also linear bearing which helps in forward & backward movement,using these bearings, we managed to make a basis for the electrode arc cutter.In specific, our system is known as a 'pantograph'.So thus the electrode arc cutter is spinning around the tube following the pantograph and removing the material that should be removed.It should be noted that without the pantograph, our machine cuts in a straight line and if it is needed to cut in an angle, the inclination for cutting is chosen according to the direction of clamp's rotation.

## Cutting electrode

For this setup we have used electrode arc as a cutting tool.In arc cutting the electrode is the most important parameter.Here we have used non consumable electrode for cutting.So using this our cutting cost has been reduced. This below table shows the electrode type with welding or cutting currents.


ELECTRODE TYPES / SIZES VS. RECOMMENDED WELDING CURRENTS

| SN. | ELECTRODE TYPE | AWS TYPE | WELDING CURRENTS (AMPS) FOR ELECTRODE SIZE (DIA) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 1. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 2. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 3. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 4. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 5. | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| 6. | [illegible] | [illegible] | - | - | [illegible] | [illegible] | [illegible] | [illegible] | - |
| 7. | [illegible] | [illegible] | - | - | [illegible] | [illegible] | [illegible] | - | - |

WELDING NOTES :

1. Recommended Polarities

2. Recommended Welding Positions

3. Current Selection Generally Adopted

## Future plans

We can make changes where errors are found.We can change the pantograph with a new & desired design & due to this we can get different notches.We are also looking for more rpm motor due to that the notching process will progress faster,increasing the cutting speed.

## Conclusion

The advantages of our construction are multiple.For example it can cut tubes of a large diameter compared to other kinds of machines that are not capable of that.It can also cut straight angles & various shapes according to the guiding ring of the pantograph.It is portable & light in weight.Its major advantage is its cost as it is much less comparing to other machines like CNC. It is also capable to cut round flanges & also different notches by using different clamps.

## References

[1] https://www.sciencedirect.com/science/article/pii/S000785060762174X.
[2] J.O. Johansson, H. Chandrasekaran, S. Gunnarsson, M. Svensson
[3] Machinability of high austenhic stainless steels -results from turning tests (in Swedish), Swedish Institute for Metals Report (1990)
IM -2676, Sept.
[4] M.C. Shaw, A.L. Thurman, H.J. Ahlgren**Plasticity problems involving plane strain and plane stress simultaneously-Groove formation in the machining of high temperature alloys**
[5] Trans, of ASME, Ser. B, J. Engr. for Industry., 88 (1966), pp. 142-146,
[6] M. Lee, J.G. Home and D. Tabor, (1979), The mechanism of notch formation at the depth of cut line of ceramic tools machining nickel base super alloys, Wear of Materials, Proc. of Int. Conference on Wear, USA, pp-460-4694
[7] H.K. Tönshoff, E. Brinksmeier**Notch wear and chemically induced wear in cutting with AI203 tools**
Ann. of CIRP, 36/2 (1987), pp. 537-543,
[8] Advani Orliekon
http://www.adorwelding.com/

# REFERENCES


- http://www.yourarticlelibrary.com/welding/thermal-cutting/arc-cutting-processes-of-metals-6-processes-welding/97720
- https://www.blocklayer.com/pipe-notching.aspx
- http://www.yashmachine.com/blog/make-tube-notches-end-notches-and-other-pipenotches-using-tube-notching-machine/
- http://www.thefabricator.com/article/tubepipeproduction/notching-options
- P.Balashanmugm and G. Balasubramanian, Design and Fabrication of Typical Pipe Cutting Machine, IJRDO-Journal Of Mechanical And Civil Engineering, ISSN: 2456-1479. Kshirsagar Prashant, Rathod Nayan, Rahate Prashant, Halaye Prashant, Surve Sachin,
- Theoretical Analysis of Multi-Way Power Hacksaw Machine, 02day, 5th international conference on recent trend in engineering, science and management, www.conferenceworld.in, (ICRTESM.16), ISBN: 978-93-86171-12-2.
- Nimbalkar Shripad, Velanje Sagar, Patil Abhay, Varpe Pooja, pnumatically operated automatic pipe-cutting machine, Vol-2 Issue-2 2016, IJARIIE-ISSN(O)-2395-4396.
- Profile Cutting Machine, Retrieved July 29, 2015 from http://img.tradeindia.com/fp/1/001/134/574.jpg
- [4] Numerical analysis of thermal profile in plasma arc cutting, ali. Moarrefzadeh, international journal of multidisciplinary sciences and engineering, vol. 2, no. 6, September 2011.
- [5] Profile Cutting Performed by an Industrial Robot, Retrieved July 29, 2015 from https://upload.wikimedia.org/wikipedia/commons/e/e5/Robotworx-plasma-cutting-robot.jpg
- [6] Control System For The Waterjet Cutting Machine, A. Hace, K. Jezernik, Member, IEEE, 2003.
- [7] FACTS ABOUT Cutting of aluminum - Aga.com, A member of linde group AGA
- [8] CNC machining centers - introduction to computer numerical control, retrieved July 26, 2015. Online available at: http://elearning.vtu.ac.in/11/enotes/CompIntManf/unit7-Nan.pdf
- [9] Profile Cutting with A CNC Machine, Retrieved July 26, 2015. Online available at: http://i.ytimg.com/vi/Ruhgyoq2zKo/maxresdefault.jpg