

Expt. No.

1

Page No.

19/4/23

Date

Aim

Study of tools and operations in sheet metal shop

Introduction to Sheet Metal

Metal used in sheet metal work

1. Galvanized iron: This is soft steel coated with zinc to resist corrosion and to improve its appearance. The zinc coating helps to prevent oxidation. Galvanized iron is used for gutters, work, furnaces and air conditioners, ventilators, tanks, guards.
2. Tin plate: Tin plate is made by coating iron sheets with pure tin. Tin sheets are available in 1 mm to 6 mm. These are used in food containers, dairy equipments, etc.
3. Copper: Copper sheet is high cost but it is used for long lasting roofing material and ducts that demand resistance to corrosion. The metal is easily fabricated because of its malleability.
4. Aluminium: It is a rust proof metal, light and has long wearing qualities. It is used for boats, flashing, roofing material as house siding and other industrial products.



Steel Foot Rule

Straight Snip

5. Stainless steel: It has a high percentage of chromium. It has a higher tensile strength and hardness than ordinary steel, therefore is harder to work. It has a good corrosion resistance. Stainless steel used for sink and other products that require strength, hardness, beauty and resistance to corrosion.

The term sheet metal implies metal and alloys in sheet rolled to thickness ranging from 10 swg and thinner. Plates are above to 10 swg thickness.

#### • Tools used in Sheet Metal Shop

##### Cutting tools:

1. Straight shear : The main purpose of the shear is to cut the sheet along the lines scribed on it. The line may be straight line or curve. For cutting along straight lines, straight shear is used whose blades are straight. Fig 1 a

##### Marking tools:

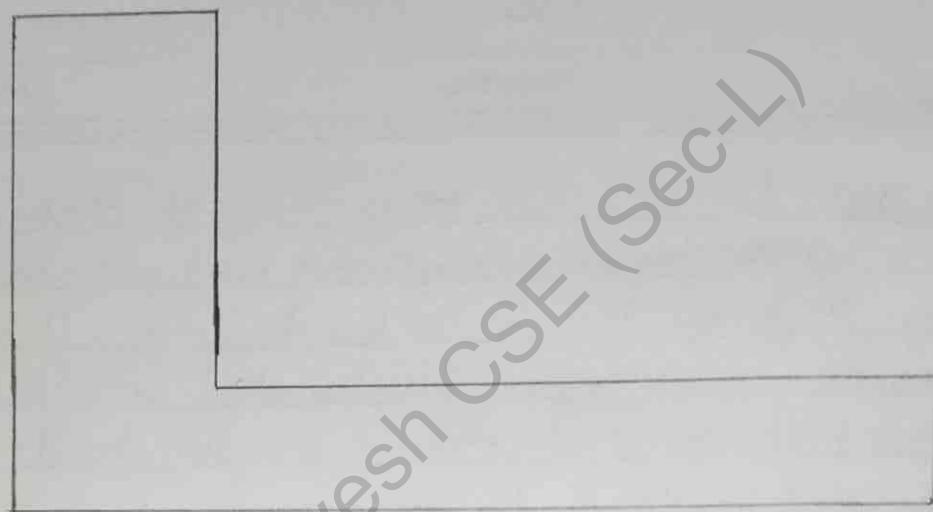
Marking tools are used to mark the sheet according to required dimensions. Various marking tools are:

1. Steel Rule: These are available in variety of sizes. The rule should be could be steel foot rule, folding rule or tape rule.

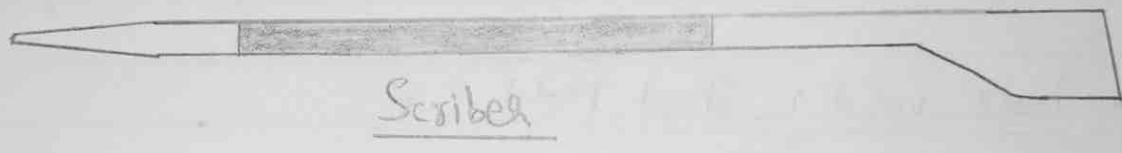
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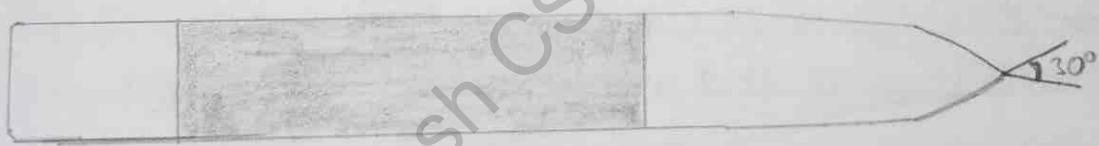
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Steel Square



Scriber



Prick Punch



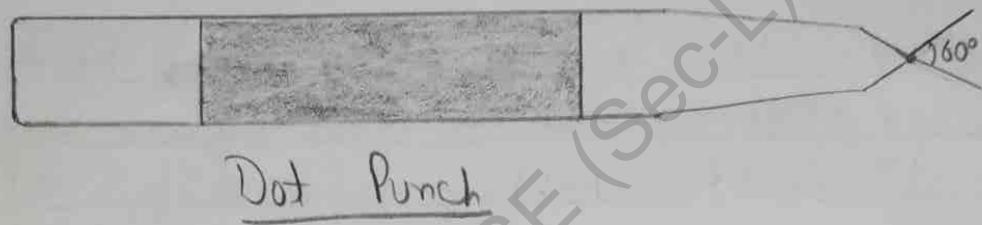
Center Punch

2. **Steel Square:** It is a L-shaped piece of hardness hardened steel. It is used to make square corners. It is also used for checking and making right angles.
3. **Scriber:** It is used to mark lines on metallic sheets. It is made up of hardened steel.
4. **Divider:** It is used for scribing arcs and circles on the metallic sheets. It is also made up of hardened steel. One leg is rested at indentation point and the other leg is used to scribe arc and circles.

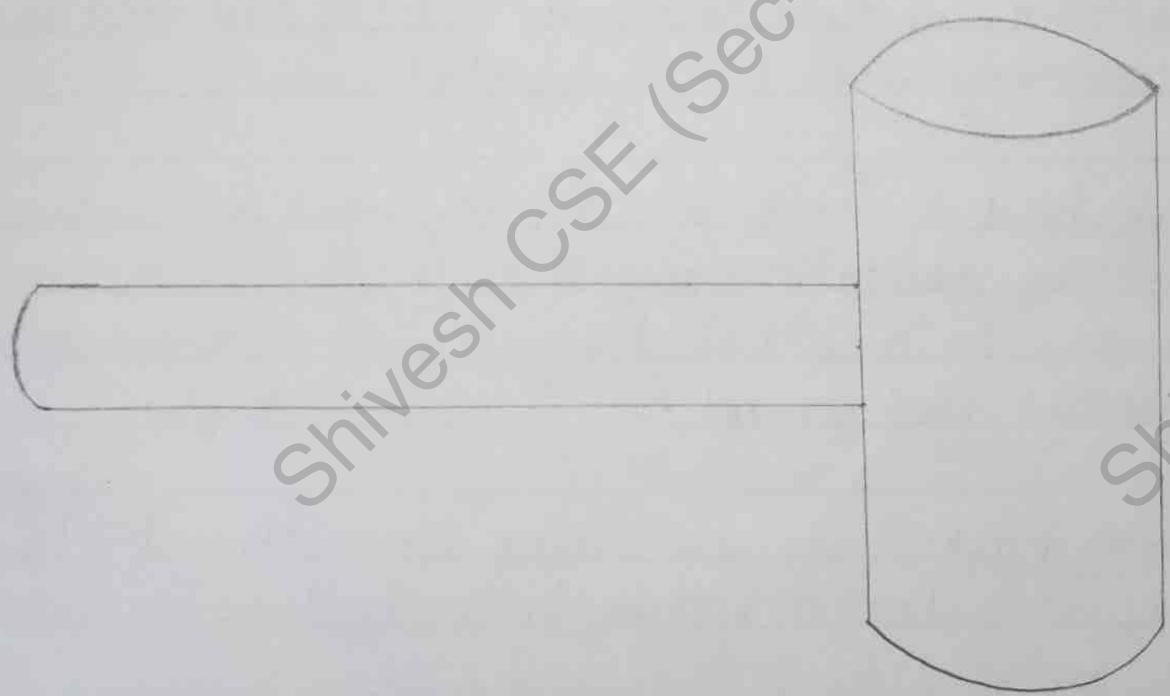
#### Punches:

The following type of punch made of tool steel are commonly used for sheet metal work.

1. **Brick Punch:** These punches are used for making small dents or indentations marks for locating the center position for divided or trammel points. The punches have tapered point ground to  $30^\circ$  included angles.
2. **Center punch:** These are used for marking the location of points and center of holes to be drilled. Its taper point is ground to  $90^\circ$  included angles.



Dot Punch



Mallet

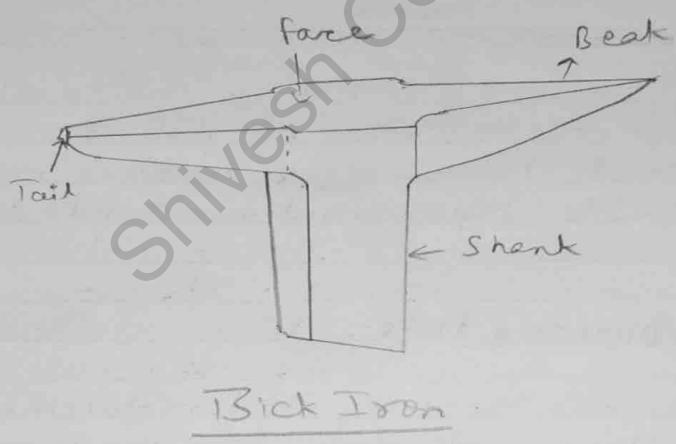
3. Dot Punch: It is used for making dotted lines. It is made up of high carbon steel or high-speed steel. One end is sharpened. Hammering is done on second end while working. Its taper point is ground to  $60^\circ$  included angles.

### Striking and Supporting tools:

The hammers are used in sheet metal shop for bending of sheets, flattening of sheets, riveting works, to give hollow or curved shape, for locking seam joints etc. For these operations, the following hammers are generally used.

Mallet: This is the most used hammer in any sheet metal shop. These are made of good quality hard wood, plastic, hard fibre. These are used whenever working on soft metal.

2. Square face hammers: This hammer is also called setting hammer and has a square flat face. It is used for flattening the seams without damaging the metal sheet.



Brick Iron

Stakes :

Stakes are supporting tools without which nearly most of the basic operations such as bending, seaming, forming, riveting, punching, etc. cannot be carried out. They are fitted in wood and jobs are worked upon them.

SHEET METAL SHOP OPERATIONS

1. Measuring and Marking : The standard market sizes of metal sheet are quite large. So, for marking articles, the required dimensions are measured and marked on the sheet.
2. Cutting Off : This means severing a piece from a strip with a cut along single line.
3. Parting : Parting signifies that scrap is removed b/w two pieces to part them.
4. Laying Out : Setting the development of the surface of the article on the sheet.
5. Notching : It is a process of removing metal to the desired shape from the side or edge of a sheet or strip.

6. Lancing: This makes a cut part away across a strip.
7. Trimming: It is an operation of cutting away excess metal in a flash from a piece.
8. Hand forming: Folding and bending of sheet in three dimensions to get required articles.
9. Soldering: Soldering is a process of joining two similar metals by using another low temperature alloy. The metal used for the joining purpose is called solder.

Aim

To make a rectangular tray with the help of given G.I. (Galvanized Iron) sheet metal piece.

Material Required

The material to be used for making rectangular tray, tray is G.I. sheet of 28 swg thickness, the size of sheet as per development (shown in main figure) is 170 mm x 150 mm.

Tools Required

1. Straight Shear (Snip)
2. Scribe
3. Try Square
4. Wood Mallet
5. Bick Iron
6. Steel Rule (foot Rule)
7. Smooth file
8. Standard wire gauge (SWG)
9. Anvil
10. Bench Vice

## • Development of sheet Metal Component

When the complete surface is open out and laid on plane, the surface of solid has been 'developed' and figure obtained is called development if the true length of the corresponding line on surface are normally developed with the inside face up.

The knowledge of development of surfaces is frequently required in the design and manufacturing of object, practical applications of developments occur in sheet metal work, pattern making, etc.

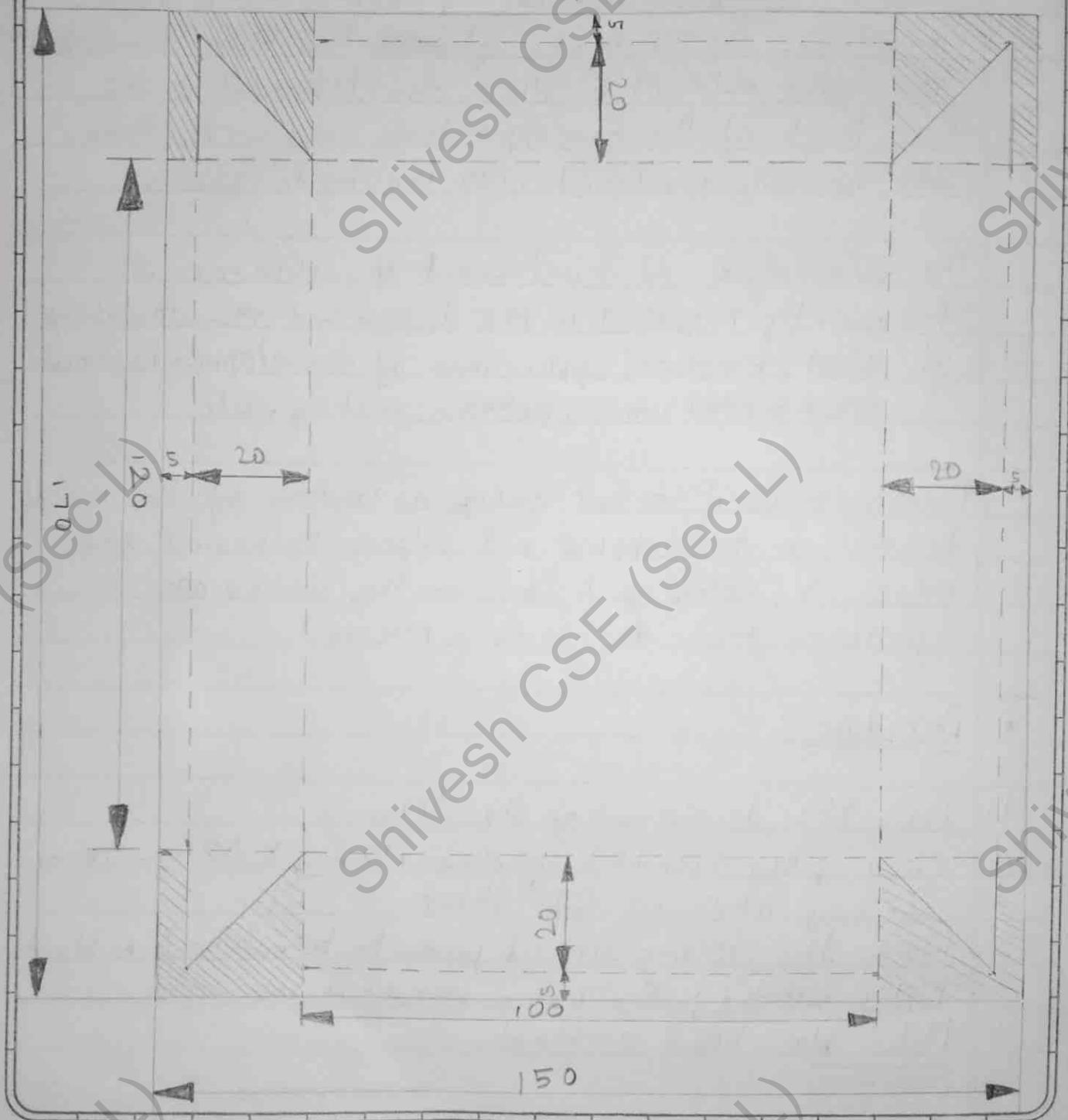
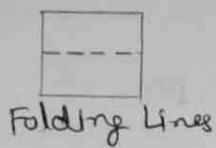
Notching is used to cut away a portion of the metal to prevent overlapping and bulging on seams and edges. The notching is done on the blanks or patterns prior to forming process.

### • Procedure :

1. Draw the development of the tray.
2. Cut a piece (blank) of size 170 mm X 150 mm from 28 swg thickness Cr.I. sheet.
3. Mark the folding lines & position to be notched on blank.
4. Notch out the portion with a straight shear.
5. Make plain head on blank.

Material: 170mm X 150mm X 32 Gauge

H.I Sheet



\* All dimensions are in mm.

5. Bend the overlapping portions.
6. Fold the blank to form tray.
7. Finish the job to required shape & size.

- Precautions

1. Perform the operations as per sequences given in procedure.
2. Use stakes of proper size to give good shapes to the job.
3. Protect your hands from sharp corners of edges of sheet.
4. Don't allow any scratch mark to come on the sheet surface.

Design length  
of handle.

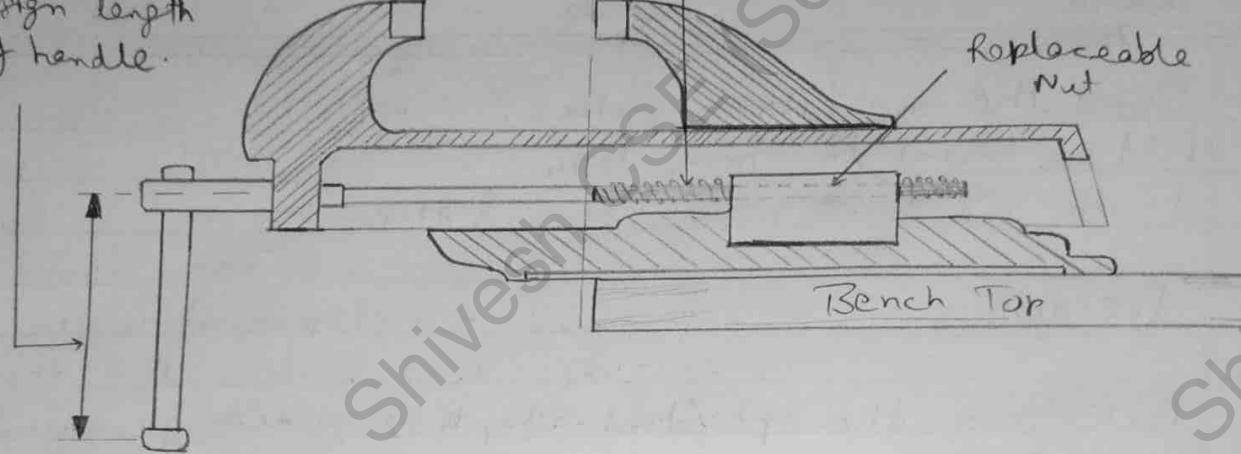


Fig. Bench vice

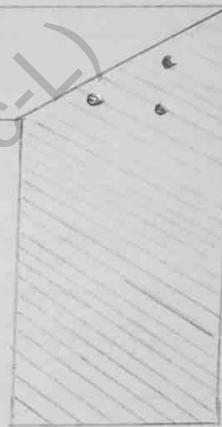


Fig. Try Square

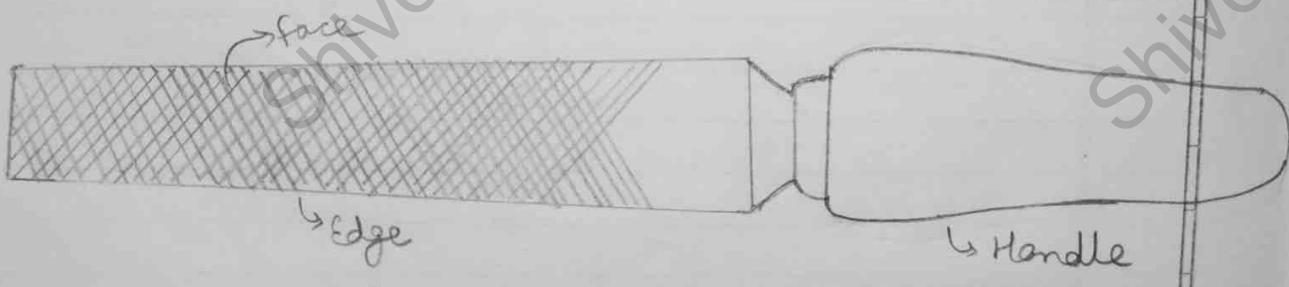


Fig. File

- Objective

To study the tools and equipment in fitting shop.

- Tools

- Vices: It is used for gripping different jobs in position during various operations. Main body and detachable jaws are made of cast steel.
- Surface Plate: It is used for testing true ness of finished surfaces, testing a try square. It is made of cast iron.
- Try Square: It is used for testing true surface at right angles or testing the true ness of normal surfaces.
- Bevel Protractor: It consists of a steel dial divided into 360 divisions. Dial can be rotated around centre. The lines at any angle can be marked or measured by the straight edge. Straight edge can be slide along length.
- Files: They are used to remove extra material by notching rubbing the metal. Files are available in a number of sizes and degree of coarseness.

Classification of files on the basis of grade :

- Rough (20 Teeth per inch)
- Bastard (30 Teeth per inch)
- Second Cut (40 teeth per inch)
- Smooth files (60-60 Teeth per inch)
- Dead Smooth (70-80 Teeth per inch)

→ Scriber : It is used for marking lines on metal /sheets.  
It is made of high carbon steel.

→ Chisel : They are used for chipping away the material from the workpiece . Chisels are generally made of high carbon steel . They are ~~6"~~ 6" to 8" long . The top is flattened and a sharp cutting edge is made at other end.

Types of Chisel

- a) flat Chisel
- b) cross cut Chisel
- c) Half round Chisel
- d) Diamond point Chisel.

Classification of Chisels

Chisels are classified with their shape and width of cutting edge.

Cutting of chisel is kept as:

- For hard materials -  $70^\circ$  to  $76^\circ$
- For Medium hard -  $60^\circ$
- For soft materials -  $46^\circ$

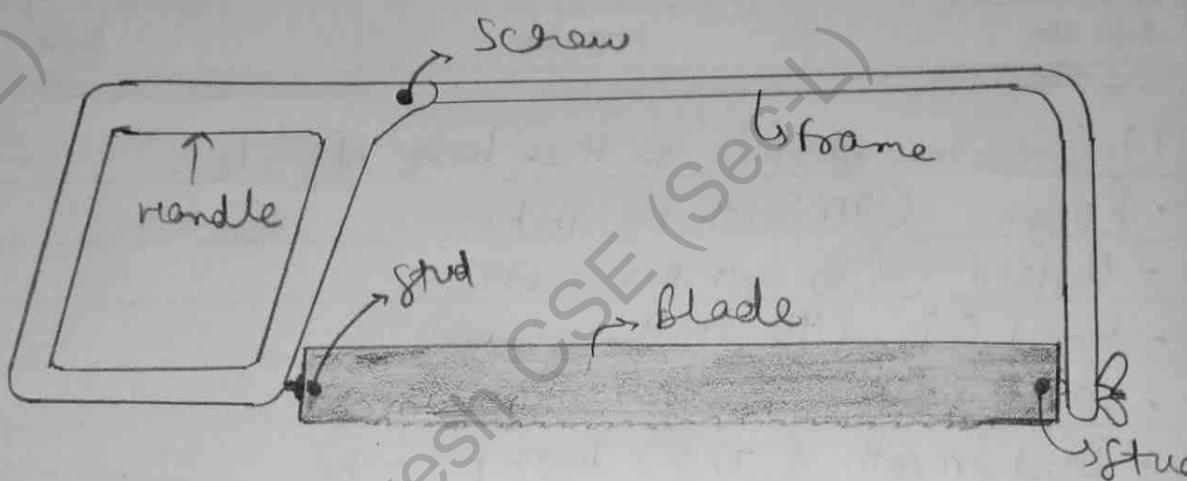


Fig. Hacksaw

→ Hacksaw: Hacksaw is used for cutting metals, flats, etc. in fitting shop.

It consists of metal frame, fitted with wooden handle, carrying metal clips with wing nuts at its ends to hold & stretch the metal blade. Teeth of blades are generally forward cut. The hacksaw should be used in straight direction otherwise it will result in breaking of blades.

The thickness of blade are  $1\text{ mm}$  &  $\frac{1}{2}\text{ mm}$  respectively.

Blades are classified as under:

- Depending upon the direction of cut
  - Forward cut
  - Backward cut
- Depending upon pitch of teeth
  - Coarse (8 to 14 Teeth per inch)
  - Medium (16 to 20 Teeth per inch)
  - Fine (24 to 32 Teeth per inch)

→ Universal marking surface gauge: It consist of a heavy base a scriber and a bar. The scriber can be adjusted to any position with the help of screw & nut. It is used for marking purpose.

→ Steel Rule: It is made of stainless steel and is available from  $\frac{1}{2}$  feet to 2 feet. These are marked in inches / millimeters.

→ Punch: It is used for marking ~~around~~ round indentation on the metal surface for providing operation of marking for further operation such as cutting, sawing, drilling and chipping, etc.

a) Dot punch

It is used for marking dotted lines. Punching angle is  $60^\circ$ .

b) Center punch

It is used to mark the centre of hole before drilling. Angle of punching end is  $60^\circ$ .

→ Hammer: It is used for striking chisels in chipping and punch in marking. A hammer consists of a heavy iron body with a wooden handle. The weight ranges from 0.26 kg to 2 kg. The main types of hammers are as follows:

- Ball peen hammer
- Straight peen hammer
- Cross peen hammer.

→ Caliper: It is used to measure inside or outside diameters of round objects. It is made up of different sizes & shapes.

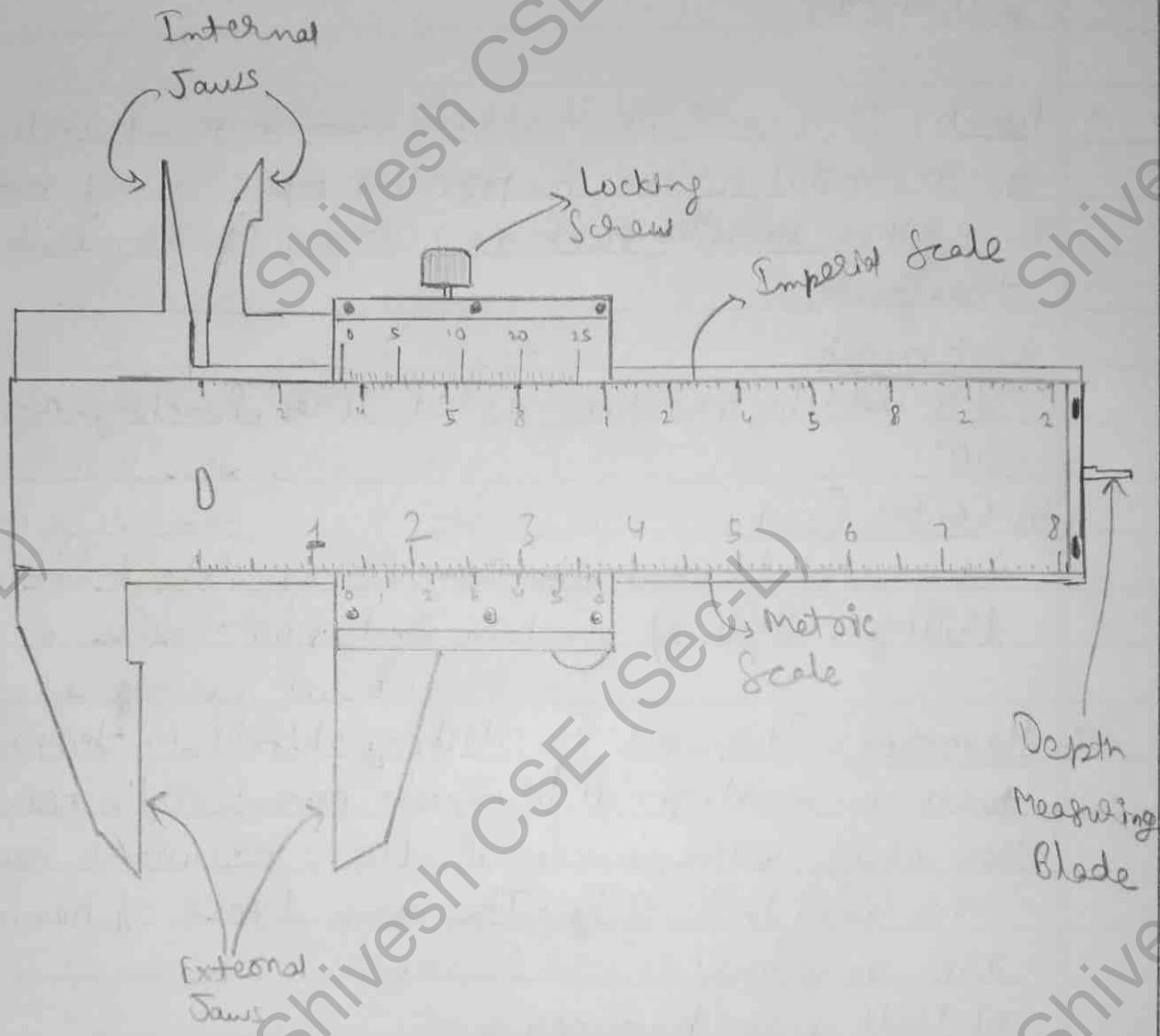


Fig. Vernier Caliper

It consists of two leg connected to one end by means of pivot or bolt. The edges are made to just to touch the job, and then diameter is measured with the help of steel rule.

These are of four types:

- a) Outside Caliper
- b) Inside Caliper
- c) Spring Caliper
- d) Odd Leg Caliper.

→ Vernier Caliper: It is used for measuring length and diameter. It can be used for measuring external and internal diameter. It can be used for measuring external and internal dimensions. The minimum dimension that can be expressed on vernier caliper is known as least count. Material of all parts is stainless steel.

• Objective: To make V section and U & T joint in fitting shop.

• Tools Required:

Vice, Try Square, Files, Scriber, Chisel, Hacksaw, Steel rule, Punch, Dot punch, Centre punch, Hammer, Vernier Caliper.

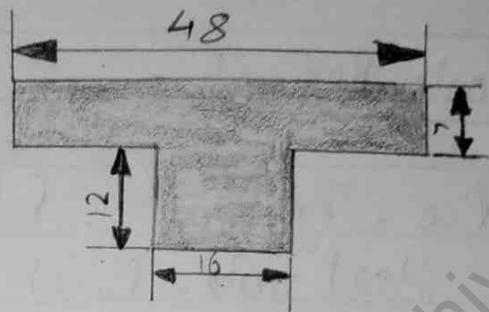
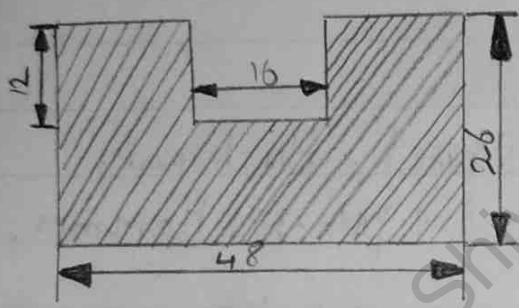
• Material Used

Two piece of mild steel, 6 mm thickness size  $48\text{mm} \times 33\text{mm}$

• Procedure

- To mark the flat with the help of steel rule & scriber.
- Hold the MS flat in the vice and cut two pieces of required dimensions with the help of hacksaw.
- Do filing, make all the side surfaces flat and check with try square repeat it on another piece.
- Now make a coating of chalk and water paste on one side of both work pieces and dry it.
- Carryout marking on both work pieced with help of scriber & steel rule.
- Remove unwanted material from the job piece with the help of hacksaw.
- file the job surface, as per the required dimensions with the help of triangular file.

Diagram



\* All dimensions are in mm

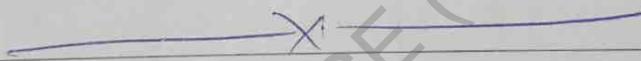
- Now check the final dimension of V slot with the help of vernier caliper.
- Now check the final dimension of T slot with the help vernier caliper.

- Result

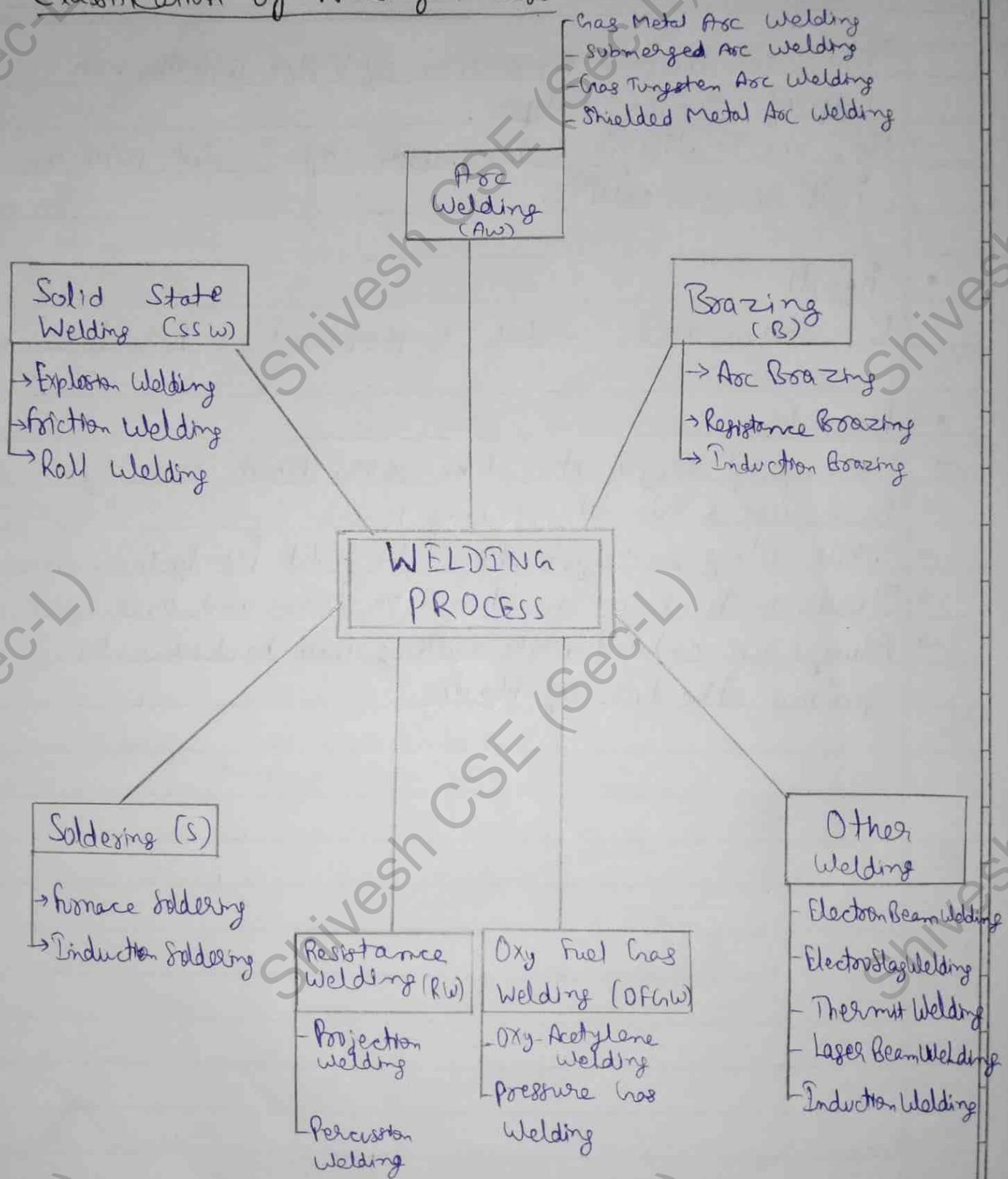
U-section and T-slot is prepared as per drawing.

- Precaution

- Marking of the job should be carried out carefully.
- Never use a file like striking tool.
- While filing the job should be hold firmly in the vice.
- Blade in hacksaw should not be loose and over tight.
- Always use coolant while cutting with hacksaw to prolong the life of blade.



## Classification of Welding Process



## OBJECTIVE

Study of tools and operation in welding shop.

- Welding

Welding is the process of joining two similar or different metals by bringing the junction to fusing point by the use of intense heat with or without application of pressure and with or without addition of filler metal.

- Electric Arc Welding

Electric arc welding is the process by which welding is done by producing heat from an electric arc, between the work and electrode. Heat generated in an arc welding is in the range of  $3600^{\circ}\text{C}$  to  $4000^{\circ}\text{C}$ . Both A.C. as well as D.C. is used in producing an arc each having its particular application.

- Equipment and tools used for metal arc welding

(1) Arc Welding Equipment: Both AC & DC are used for arc welding, when DC arc is to be employed the current is generated by a DC generator. This generator can be given by means of an electric motor or by means of a

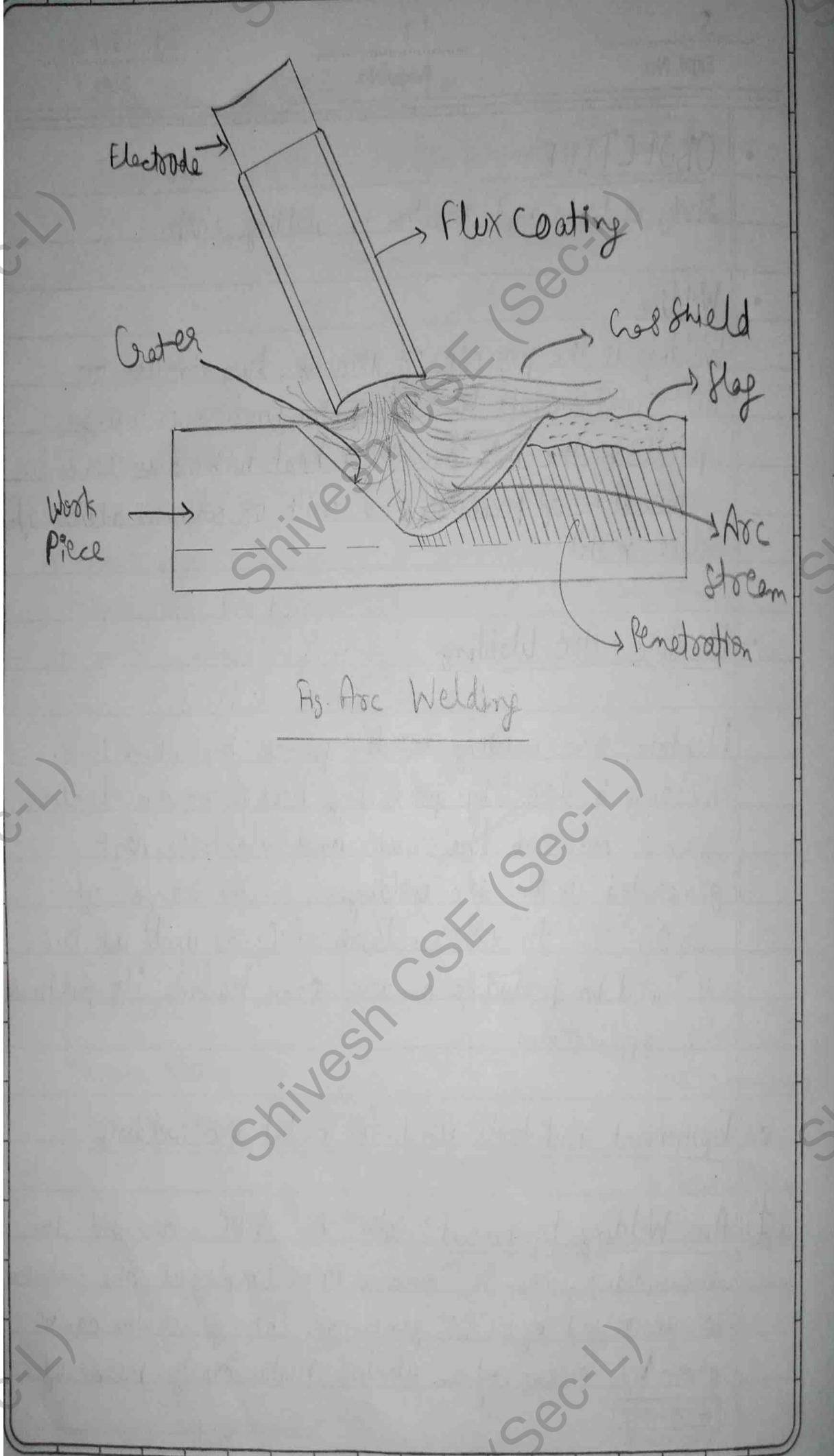


Fig. Arc Welding

petrol or diesel engine.

For A.C. arc welding a step-down transformer is used which receives current from the supply mains at 400-440 volts and transforms it to the required voltage voltage for welding i.e. 80-100 volts.

## (2) Face Shield / Hand Screen

When arc is produced around the job, infrared rays and UV rays are produced. To protect the face and eyes from these dangerous rays, a shield is necessary. The body of a shield is made of fiber glass and coloured glasses are used to see the arc. The coloured glasses of different shades are available for welding and cutting.

Shade no. 10 is used for metal arc welding and 14 for Plasma cutting.

(3) Hand Gloves, Apron and Leather Shoes: The hand gloves, apron and leather shoes are used to protect hands, cloths and foot while welding. These are made of leather or asbestos material.

(4) Cables or Leads: These leads are made up of copper or aluminium wire. The wires are insulated with rubber and cloth fiber. A heavy insulation is necessary for these cables.

### 5) Electrode Holder

It is connected to electrode lead and is used to hold the metallic electrode during metal arc welding. It should be light in weight balanced insulated except jaws, heat resistant and easy to receive and eject electrode.

### 6) Cleaning Tools

Chipping hammer and wire brushes are used to clean the weld area & to remove slag and spatter. The chipping hammer is generally double ended having a point at one end and a flat chisel shape at the other.

### 7) Chipping Goggles

This is worned to protect eyes from slag during chipping process.

### 8) Tong: It is made of forge steel and is used to hold the work piece

### 9) Electrode: Electrodes are of two types.

i) Coated Electrodes: Coated electrodes are generally applied in arc welding process. Metallic core is coated with some suitable material. The material used for core are mild steel, nickel steel, chromium, molybdenum steel, etc. one end of coated core is kept bare for holding.

### ii) Bare electrode

Bare electrode produce the welding of poor quality. These are cheaper than coated electrodes. These are generally used in modern welding process like MIG welding.

### 10) Fire Extinguisher :

They are used to prevent the fire that may break out of chance. Sand filled baskets and closed cylinders are kept ready to meet such accidents.

### Objective

To make a single V shape Butt joint with given piece of mild steel by using arc welding.

### Equipments

A.C. Welding set air / oil cooled transformer.

### Tools Used

- |                                       |                     |
|---------------------------------------|---------------------|
| 1) Electrode Holder                   | 6) Tongs            |
| 2) Earthing clamp                     | 7) Chipping Hammer  |
| 3) Hand Screen                        | 8) Chipping Goggles |
| 4) Hand Gloves, Apron & Leather Shoes | 9) Welding Table    |
| 5) Wire Brush                         |                     |

### Materials Required

Two mild steel pieces of given size  $60 \times 50 \times 5$  mm

Electrode - 3.15 mm

Welding position - D/H (Down Hand)

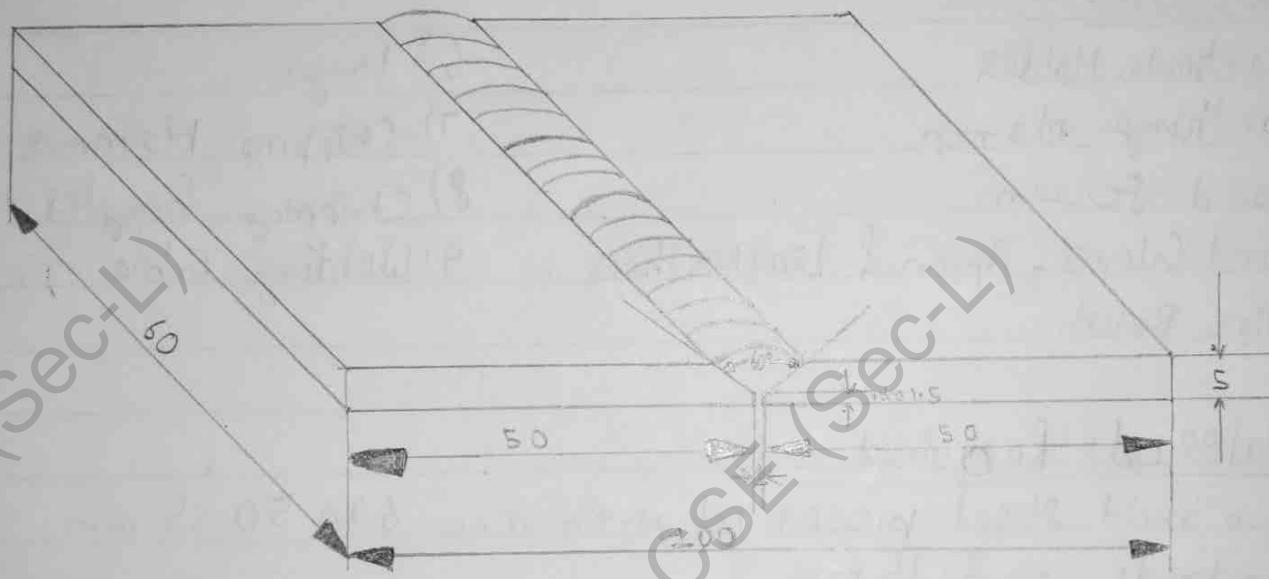
Current required - 90 to 120 Amp.

### Procedure

- 1) Cut the work pieces according to given dimensions.
- 2) To make the pieces V shaped, first punch the piece its width side 1 mm and then punch it at  $30^\circ$  from punching line.

Similarly, the second piece is also been punched. So the

• Diagram



\* All dimensions are in mm

including angle both the pieces is  $60^\circ$  and then the punching lines are filled filed. Hence the V shape is made.

- 3) Start the welding machine & set current 90 to 120 amp.
- 4) Connect earthing clamp to the base plate and keep the job ~~on~~ on the base plate.
- 5) Put electrode in the electrode holder.
- 6) Now both the pieces are kept in front providing the gap of 1mm between to avoid distortion and to get good penetration and fusion in the pieces.
- 7) Now put the tag on the upper and lower side of the pieces and one tag on the opposite side of the pieces at the centre to stop the distortion. Then the welding bead is made from V shape side, top to bottom.
- 8) Chip off the slag by chipping hammer and clean the joint by wire brush.

- Result

A proper V shape Butt joint has been achieved / made.

- Precautions

1. Never look at the arc by naked eyes. Use the welding screen or goggles.
2. Always wear the safety hand gloves, apron & leather shoes.

- 3) Never chip slag while it is hot, without wearing chipping goggles.
- 4) Avoid use of damaged tools.
- 5) Always use tongs for holding the heated job.

\_\_\_\_\_ X \_\_\_\_\_

## • Objective: Safety Precautions

When operator enters into the workshop, he should first observe safety to save himself/ herself and others.

### I. Precautions in Machine Shop

- i) Do not lean against any machine, it is very dangerous.
- ii) Do not work on a machine in Dim light.
- iii) Never switch on a machine unless or otherwise you know all mechanism and operation of machine.
- iv) When using any grinding parts, protect the eyes by wearing goggles or using shields.
- v) Do not clean metal chips by hand, use wire brush for cleaning.
- vi) Be in a habit of cleaning the machine, equipment and tools regularly.

### II. Precautions in workshop

- i) Keep the workshop neat & tidy. Avoid tipping over things and tripping over gangways.
- ii) Do not run in the workshop. Walk carefully.
- iii) See that the floor is free from slippery substances.
- iv) Keep pathways clean and clear.
- v) Everything should be in place and throw waste material

into the dustbin.

- vi) Workshop should have proper <sup>lighting</sup> & ventilation.

### III. Precautions while using hammer

- i) There should be no grease or oil on the handle.
- ii) Hammer head should not be projecting outward.
- iii) Handle should not be too long or too short.

### IV. Precautions while using chisel

- i) It should be handled carefully and must be grounded.
- ii) Goggle must be used while chipping.

### V. Precautions while using file

- i) The finger of left hand must not be crooked under under file as this may injure the fingers.
- ii) Metal chips must not be removed while doing job by bare hands, brush is to be used.
- iii) Files without handles or those with crook must not be used.

### VI. Precautions during welding

- i) Acetylene or oxygen cylinder must be kept separately.
- ii) Do not weld in confined space without adequate

ventilation.

- (ii) We should always use goggles while welding.
- (iv) Make sure that connection are airtight by using soapwater.
- v) Never use matches for lighting while welding.
- vi) When welding is to be stopped, close the cylinders and release gas pressure.
- vii) Do not touch the electrode or the work circuit.
- viii) Always wear gloves without holes.
- ix) Wear eyes protection at all times during during welding.

## VII. Precautions on clothing

- i) Tight fitting coats are safer than loose fitting coats.
- ii) Avoid wearing rings, long & sleeved shirts & watches while working.
- iii) Clear covered footwear having thick soles & tough above.
- iv) Hair must be tied up properly.

### • Objective

To perform job involving turning (Step & Taper), knurling & grooving practices on lathe machine.

### • Materials Required

Mild steel round bar (200mm)

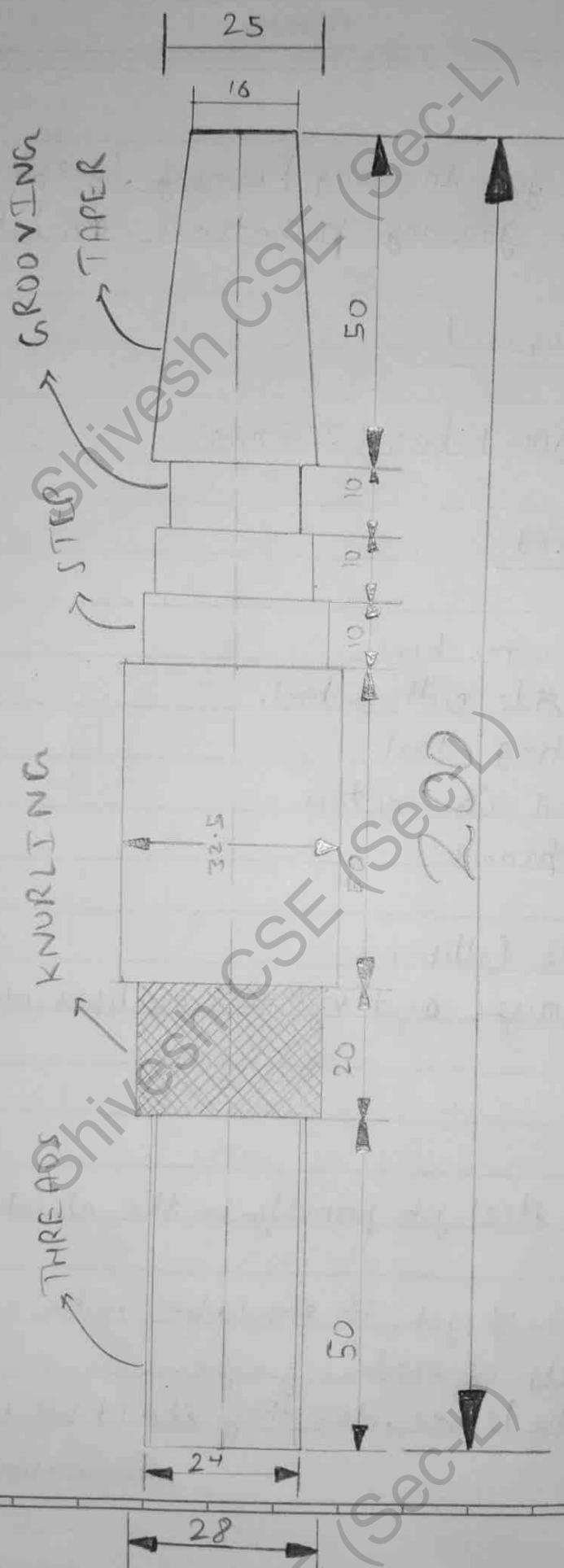
### • Tools Required

- ① Centre Lathe machine
- ② Right hand side cutting tool.
- ③ Vshape cutting tool.
- ④ Knurling and Grooving tool.
- ⑤ Tool post spanner.
- ⑥ Steel rule
- ⑦ ~~Out~~ Outside calliper.
- ⑧ Surface gauge and vernier calliper, etc.

### • Procedure

- Hold mild steel job properly in the chuck on lathe machine.
- Check position of job, it should be in the centre of chuck with the help of surface gauge.
- Check all the leaves, etc. they should be unengaged before

• Diagram



\* All dimensions are in  
mm

Fig. Machined Part on Sheet No 2

starting the machine.

- After switching on machine, see visually the approximate centre of job. It should not revolve in elliptical position.
- Switch off the machine & mount the tool bit in the tool post in proper position. It should be well tightened and tip of tool bit should coincide with the centre of job.
- Tilt the position of tool post post in such a manner that the tip of tool bit come about 30-40 degree with job.
- Then feed tool post towards job with help of cross slide till the tip of tool bit reach at centre of job. This process of metal removing is known as facing.
- After facing, tilt back the tool post to its previous position so that the tip of tool bit come at right angle position with job. Now feed will be given with help of carriage. This metal removing process from surface of job is called plain turning & when a workpiece having different diameters is turned, the surface forming step from one diameter to other is called step turning.
- Fix the carriage into position. Now tilt compound rest to desired angle. And feed tool into job with help of cross slide & compound rest feed handle.

Angle of taper can be calculated as:

$$\tan \alpha = \frac{D-d}{2L}$$

where D = Large diameter ; d = small diameter ; L = Length of tapered.

X  For grooving operation engage back gear

- For grooving operation, fix the grooving tool on the tool post. Feed the tool into the revolving job with help of carriage and cross slide to get grooving of required dimensions as shown in figure.
- After grooving engage back gear and reduce speed of spindle & replace the grooving tool bit with knurling tool bit and press it over the surface to be knurled.
- For threading, engage the feed rod lever and suitable gears in proper way, etc. Now threading tool will be moved with the help of half nut lever.

- Result

The various machinery or machining operations had performed on Lathe Machine.

- Precautions

- ① Know basics of operational mechanism very well before operating Lathe machine.
- ② Do not wear loose clothes.
- ③ Adopt always right tool and right mechanism.
- ④ Always check that all gears and levers should be engaged or in ideal position before switching on the machine.

- ⑤ Make sure that job and tool bit are mounted well in proper position and tightened enough before starting machine.
- ⑥ Use proper feed to the tool bit along with appropriate speed.
- ⑦ Never use outside calliper / steel rule / vernier calliper etc. in running condition.
- ⑧ Threading and knurling should be done on minimum speed along with sufficient cutting fluid/ coolant, etc.
- ⑨ If you are feeling any abnormality in sound etc. of machine, switch off the machine and inform the shop in-charge immediately.