# INTRODUCTION

Welding is a process for joining two similar or dissimilar metals by fusion. It joins different metals/alloys with and without the application of pressure and with or without the use of filler metals. The fusion of metal takes place by the means of heat. The heat may be generated either from combustion of gases, electric arc, electric resistance or by chemical reaction. Welding provides a permanent joint but it normally affects the metallurgy of the components. It is therefore usually accompanied by post weld heat treatment for most of the critical components.

Welding is dependable, efficient and economic method for permanently joining similar metals in other words, you can weld steel or aluminium, joining similar metals in the permanent bond but you cannot weld steel to aluminium using traditional welding process.

Welding is used extensively in all sector of manufacturing from earth moving equipment to the aerospace industry. The welding is widely used as a fabricator and repairing process in industries. some of the typical applications of welding include the fabrication of ships, typical vessels, automobiles bodies, off shore platform, bridges, welded pipes sealings of nuclear fuel and explosive ect.

| | | | |
|---|---|---|---|
| 1 | OXY-FUEL GAS WELDING | 3 | RESISTANCE WELDING |
| → | Air – acetylene welding | → | Spot welding |
| → | Oxy – acetylene welding | → | Seam welding |
| → | Oxy - hydrogen welding | → | Prosection welding |
| → | Pressure gas welding | → | Resistance butt welding |
| 2 | ARC WELDING PROCESS | → | Flash butt welding |
| → | Carbon arc welding | → | Percussion welding |
| → | Shielded metal arc welding | → | High frequency resistance |
| → | Submerged arc welding | → | High frequency induction |
| → | Gas tungsten arc welding | 4 | THERMAL WELDING |
| → | Gas metal arc welding | → | Thermit welding |
| → | Plasma metal arc welding | → | Pressure thermit welding |
| → | Atomic hydrogen welding | 5 | RADIANT ENERGY WELDING |
| → | Electro slag welding | → | Laser welding |
| → | Electro gas welding | → | Electron beam welding |
| → | Stud arc welding | | |
| | SOLID STATE WELDING | | |
| → | Forge welding | → | Explosive welding |
| → | Cold pressure welding | → | Diffusion welding |
| → | Friction welding | → | Cold pressure welding. |
| → | Thermo compression welding | | |

# Classification Of Welding Process

Forge OR Pressure Welding (Under pressure without additional filler metal)

Fusion or non pressure Welding (With additional filler metal)

## Forge or Pressure Welding

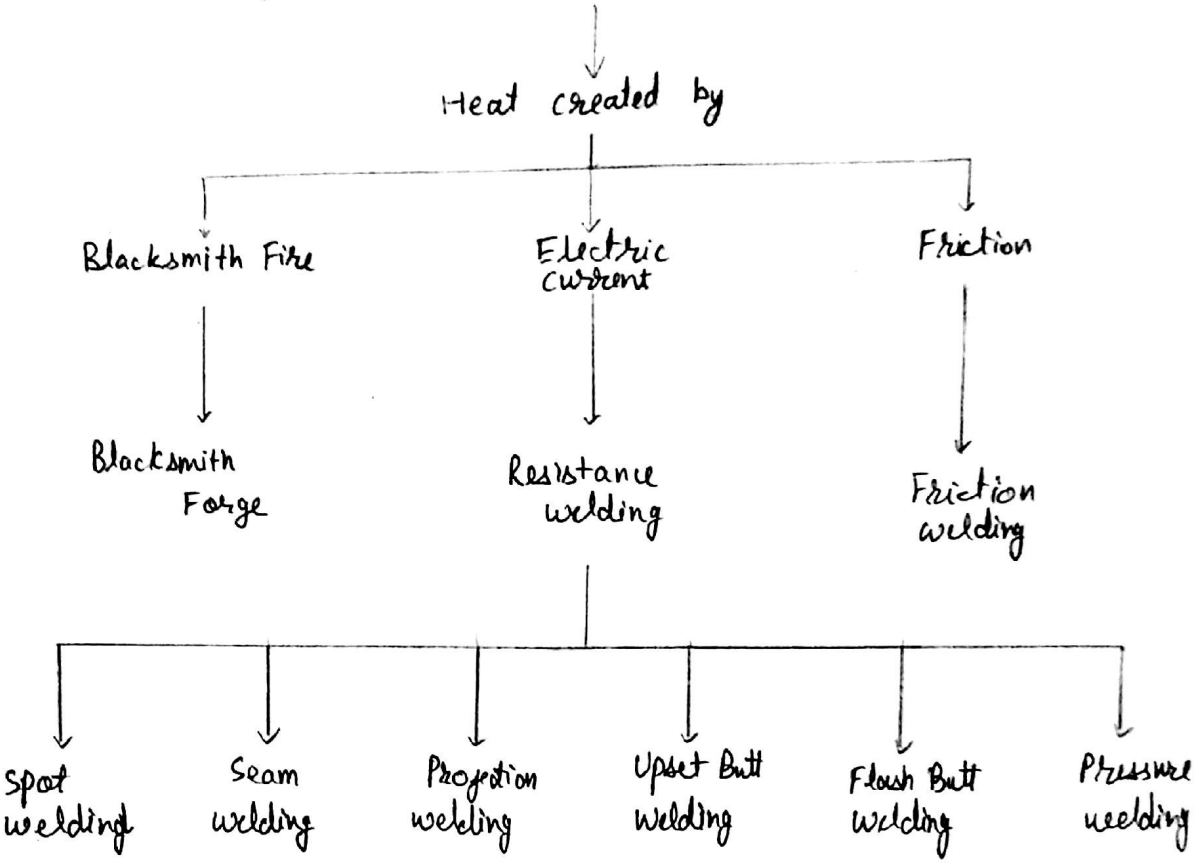
The work piece are heated to plastic state and then work pieces are joined together by applying pressure on them in this case no filler material is reaquired.

## Fusion or Non-Pressure Welding

Here edge of work piece to be joined and filler material both are heated to a temperature above the melting point of the metal and then allow to solidify

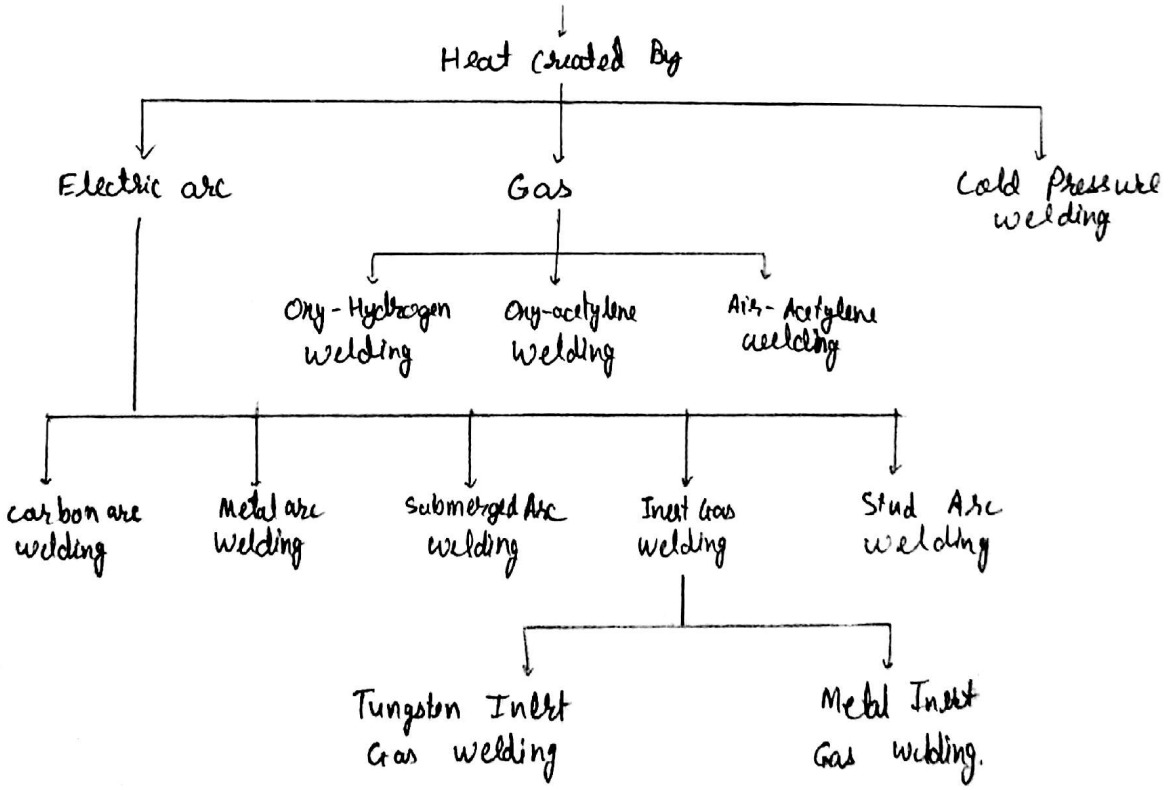
# PRESSURE OF FORGE WELDING

(Under pressure without additional filler metal)

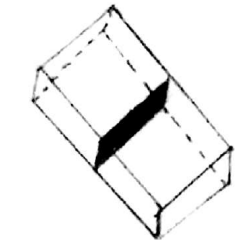



# FUSION OR NON PRESSURE WELDING

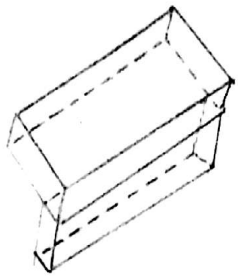
(With additional Filler Metal)



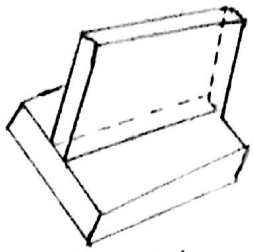
# TYPES OF JOINTS IN WELDING



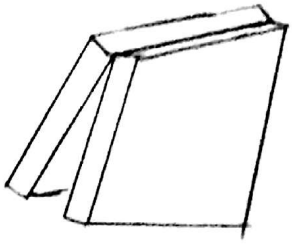
Butt Joint



Corner Joint



T joint



Edge joint

## Welding Positions

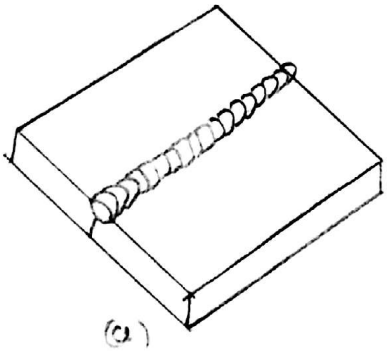
Welding positions defined here are for groove welds :-

(a) Flat

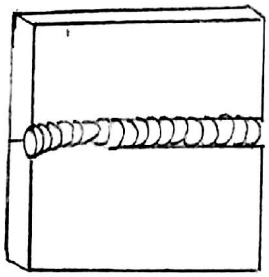
(b) Horizontal

(c) Vertical

(d) Overhead.



(a)



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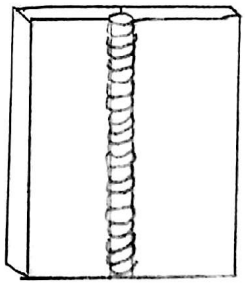
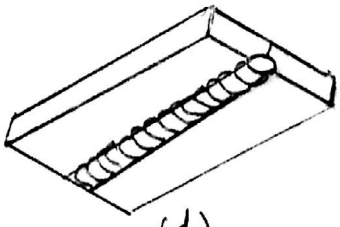


(c)



(d)

# ADVANTAGES

→ Welding is more economical and is much faster process as compared to other process

→ Welding if properly controlled results permanent joints having strength equal or sometimes more than base metal

→ Large number of metals and alloys both similar and dis-similar can be joined by welding

→ General welding equipment is not very costly

→ Portable welding equipments can be made easily available

→ Welding permits considerable freedom in design

→ Welding can join welding jobs through spots, as continuous pressure tight seams, end to end and in a number of other configurations

→ Welding can also be mechanised.

# DISADVANTAGES

→ It results in residual stresses and distribution of workpiece

→ Welding joints needs stress relieving and heat treatment

→ welding gives out harmfull radiation, fumes and spatter

→ Jigs and fixtures may also be needed to hold and position the parts to be welded

→ Edges preparation of the welding jobs are required by welding

→ Skilled welder is required for production of good weld.

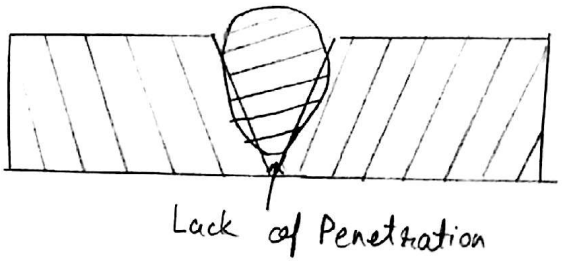
→ Heat during welding produces metallurgical changes the structure of the welded joint is not same as that to the parent metal

# DEFECTS

## 1) Lack Of Penetration

It is the failure of the filler metal to penetrate into the joint. It is due to :-

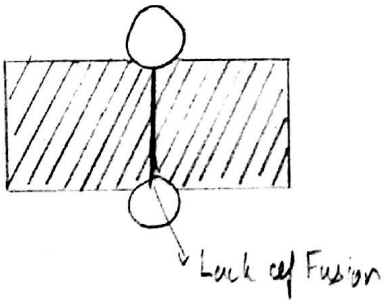
(a) Inadequate de-slagging
(b) Incorrect edge penetration
(c) Incorrect welding technique

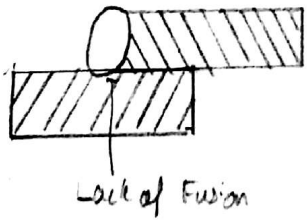


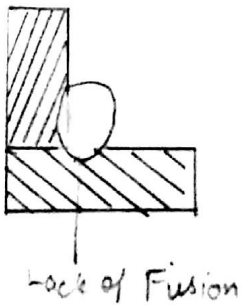

## 2) Lack Of Fusion

It is the failure of the filler metal to fuse with the parent metal. It is due to :-

(a) Too fast travel
(b) Incorrect welding technique
(c) Insufficient heat



## 3) Porosity

It is a group of small holes throughout the weld metal. It is caused by the trapping of gas during the welding process, due to

(a) Chemicals in the metal

(b) Dampness

(c) Too rapid cooling of weld.

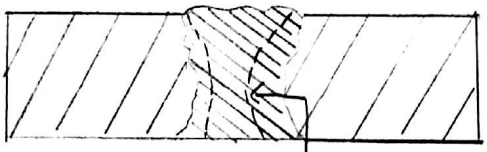
Porosity

## 4) Slag Inclusion

It is entrapment of slag or other impurities in weld it is due to,

(a) Slag from previous runs not being cleaned away

(b) Insufficient cleaning and preparation of the base metal before welding commences



Slag

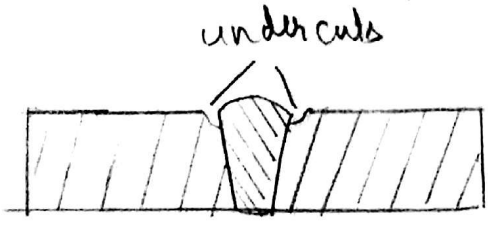
## 5) Undercuts

These are grooves or slots along the edges of weld, caused by

(a) Too fast a travel

(b) Bad welding technique

(c) Too great a heat build-up



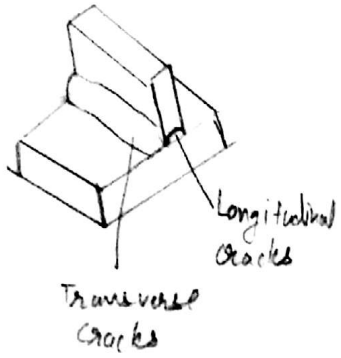
undercuts

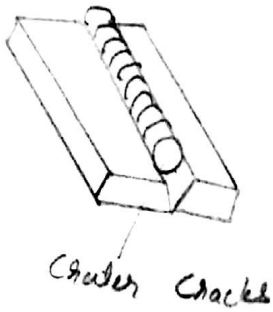
## 6) Cracking

It is the formation of cracks either in the weld metal or in the parent metal. It is due to.

a) Unsuitable parent metal used in the weld

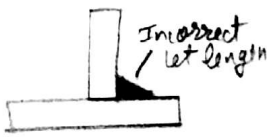
b) Bad welding technique

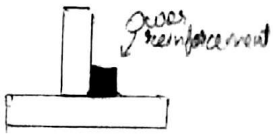


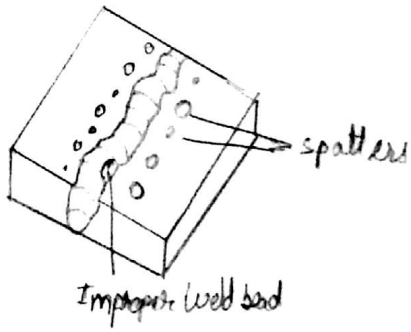




## 7) Poor weld Bead Appearance

If the width of weld bead deposited is not uniform or straight, then the weld bond is termed as poor it is due to improper arc length improper welding technique, damaged electrode coat and poor electrode and earthing connections. It can be reduced by taking into consideration the above factors

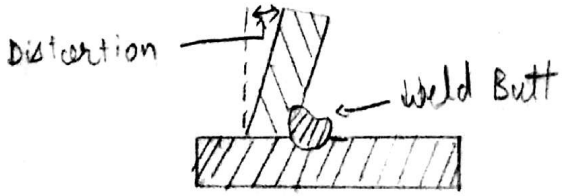



## 8) Distortion

It is due to high cooling rate, small diameter electrode, poor clamping and slow arc travel speed



9) Overlays

They consist of metal that has flowed on to the parent metal without fusing with it This defect is due to

(a) Contamination of the surface of the parent metal

(b) Insufficient heat

10) Blowholes

These are large holes in the weld caused by

(a) Gas being trapped, due to moisture

(b) Contamination of either the filler or parent metals

11) Burn through

It is collapse of the weld pool due to

(a) Too great a heat concentration

(b) Poor edge preparation.

12) Excessive Penetration

It is where the weld metal protrudes through the root of the weld it is caused by

(a) Incorrect edge preparation

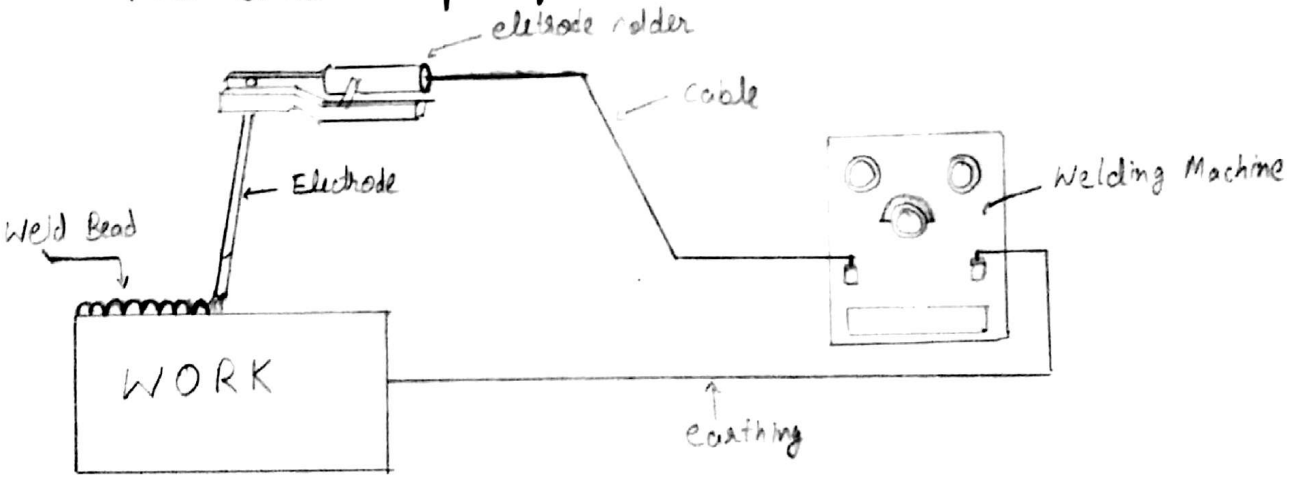
(b) Too big heat concentration

(c) Too slow travel.

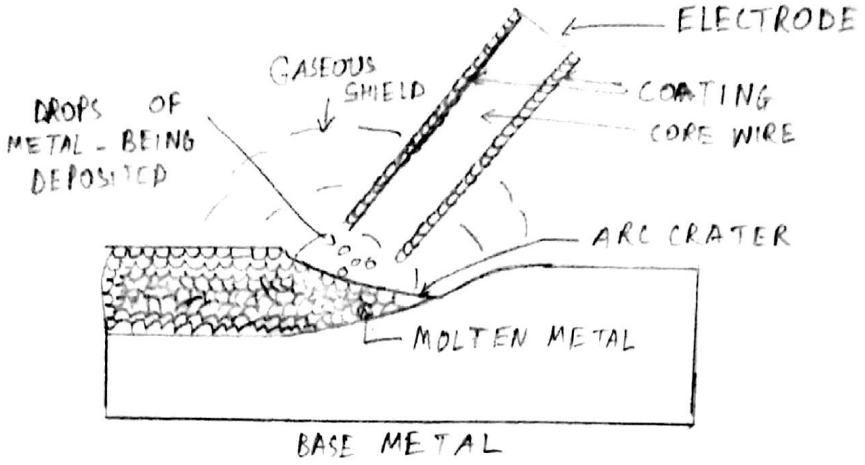
# SHIELDED METAL ARC WELDING (SMAW)
## OR
## MANUAL METAL ARC WELDING (MMAW)

Shielded metal arc welding (SMAW) is a commonly used arc welding process manually carried by welder. It is an arc welding process in which heat for welding is produced through, an electric arc set up between a flux coated electrode and the workpiece. The flux coating of electrode decomposes due to arc heat and serves many functions, like weld metal protection, arc stability etc. Inner core of the electrode supply the filler materials for making a weld if the parent metal is thick it may be necessary to make two or three passes for completing the weld.

The Basic setup of MMAW is depicted.



The configuration of weld zone is shown in fig.




# ARC WELDING EQUIPMENT

## 1) Arc Welding Power Source

Both direct current (DC) and alternating current (AC) are used for electric arc welding, each having its particular application. For AC welding supply, transformer are predominantly used for almost all arc welding where mains electricity supply is available they have to step down the usual supply voltage (200-400V) to the normal open circuit welding voltage (50-90)V

## 2) Welding Cables

Welding cables are required for conduction of current from the power source through the electrode holder, the arc, the workpiece and back to the welding power source. These are insulated copper or aluminium cables

## 3) Electrode Holder

It is used for holding the electrode manually and conduct current to it. These are matched to the size of the load which in turn matched to the amperage output of the arc welder. Electrode holder are available in sizes that range from 150 to 500 Amps.

## 4) Welding Electrodes

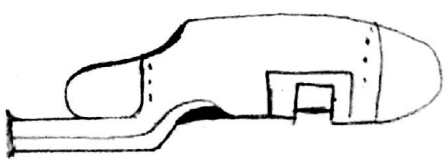
An electrode is a piece of wire or a rod of a metal or alloy, with or without coolings. An arc is set up between electrode and workpiece. Welding electrodes are of two types

(a) Consumable Electrodes
   1) Base electrodes
   2) Coated electrodes

(b) Non-consumable Electrodes
   1) Carbon or Graphite electrodes
   2) Tungsten electrodes

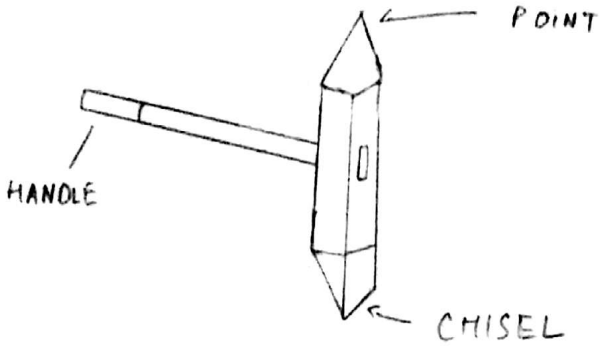
## 5) Hand Screen

It is used for protection of eyes and supervision of weld bead.



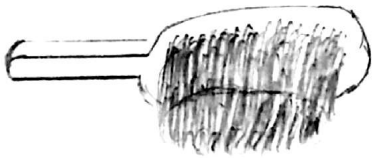
## 6) Chipping Hammer

It is used to remove slag by striking




## 7) Wire Brush

It is used to clean the surface of weld



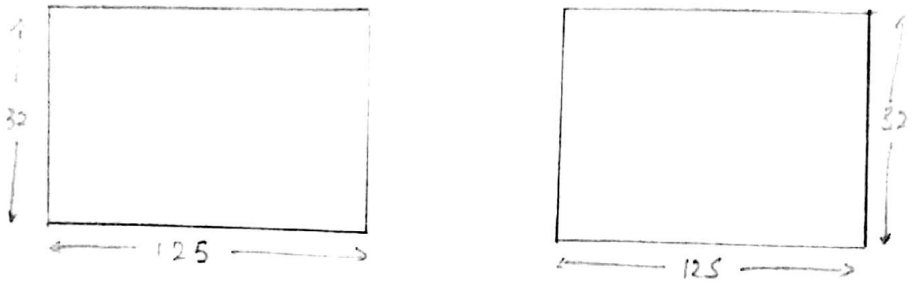
## 8) Protective Clothing

Operator wears the protective clothing such as apron to keep away the exposure of direct heat to the body.

# JOB

Aim : To make a butt joint by arc welding of two mild steel pieces.

Job : Two mild steel pieces of dimension 125 X 32 X 5 mm




Job for butt Joint

## Tools And Equipment :

a) AC welding machine
b) welding electrode
c) face shield
d) File
e) hand gloves
f) Chipping hammer
g) welding table
h) Bench vice
i) Wire brush
j) Flexible grinder

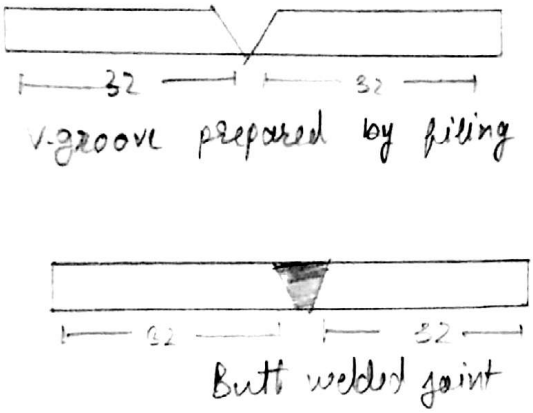
## Procedure :

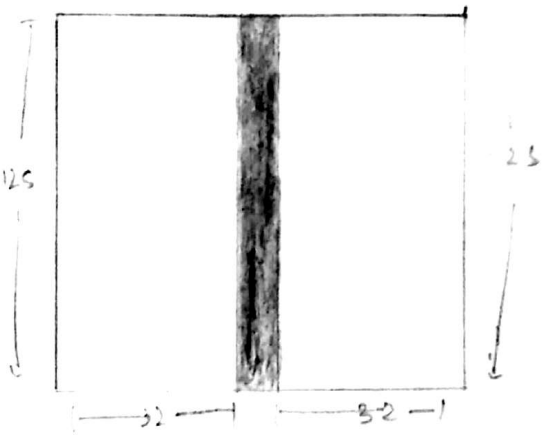
1) Hold metal pieces one by one in the bench vice and clean the surface by wire brush
2) File the edges of the metal pieces which are to be welded so as to obtain V-groove when they are placed side by side. Edges can also be grounded by a flexible grinder.
3) After edge preparation, set the metal pieces on the welding bench with edges prepared touching each other using clamp.
4) Fix a welding electrode into the electrode holder of the arc welding machine. The clamp of the machine is grounded to welding table

5) Switch on the machine and bring electrode to metal pieces
6) Start the welding process by initiating arc between the electrode and the interface of the material pieces. Carry out the welding throughout the
7) Switch off the machine after completing the welding
8) Lift the jointed workpieces with tong and drop it into water for cooling
9) Remove the slag using wire brush or chipping with hammer.

## Result:

The required butt joint of metal piece is obtained.




## Precautions:

1) Use welders eye shield while welding
2) Wear leather gloves and apron
3) Move the electrode gradually ensuring proper filling of the joint by the molten weld.
4) Do not touch the metal piece unless cooling has been done