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Introduction

Welding is a process of joining similar metals by application of heat with or without application of pressure and addition of filler material. The result is a continuity of the homogeneous material of the composition and characteristics of two parts which are being joined together. The application of welding are so varied and extensive that it would be an exaggeration that doesn't make use of welding in one form or another. In fact, the future of any new material may depend on how fast it would find itself to fabrication by welding.

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Safety Precautions in welding shop :

- All instructions applied by the manufacturer should be strictly followed.
- Working area and floor should be kept clean and clear of all electrode stuffs, metal scraps, etc.
- Before starting welding, ensure that the welding equipment is properly earthed.
- Do not look at an electric arc with naked eye.
- Any combustible or inflammable material should not be placed near welding.
- Fire extinguishers or sand should be available at hand.
- Working gloves should always be used for picking up hot objects.
- Gas cylinders should be stored in ventilated, dry place.
- Use goggles with no inflammable lenses and frames.

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- Before undertaking any maintenance work on welding machine, disconnect them from the main supply.
- Welding cables should be completely insulated.
- Always tight fitting dresses should be worn during welding.

classification of welding.i) Arc welding.

- 1) Metal-arc welding without gas protection.
- 2) Metal-arc welding with covered electrode.
- 3) Gravity arc welding with covered electrode.
- 4) Bare wire metal arc holding.
- 5) Flux-cored metal arc welding.
- 6) Air carbon arc welding.
- 7) Submerged arc welding.
- 8) Submerged arc welding with wire / strip electrode.
- 9) Gas shielded metal arc welding.
- 10) MIG welding.
- 11) MAG welding, metal arc welding with non-inert gas shield.
- 12) Gas shielded welding with non-consumable electrode.
- 13) TIG welding.
- 14) Atomic-hydrogen welding.
- 15) Plasma arc welding.
- 16) Other arc welding process.
- 17) Carbon arc welding.
- 18) Rotating arc welding.

(ii) Resistance welding.

- 1) Spot welding
- 2) Lap beam welding
- 3) Seam welding with strip.
- 4) Flash welding
- 5) Projection welding
- 6) Flash welding
- 7) HF Resistance welding.

(iii) Gas welding:

- 1) Oxy-fuel gas welding.
- 2) Oxy-acetylene gas welding
- 3) Oxy-propane welding
- 4) Oxy-hydrogen welding.
- 5) Air fuel gas welding.
- 6) Air propane welding.

(iv) Solid phase welding, pressure welding:

- 1) Ultrasonic welding
- 2) Friction welding
- 3) Force welding
- 4) Cold welding
- 5) Diffusion welding

- 6) Gas pressure welding
- 7) Cold welding.

(v) Other welding processes:-

- 1) Thermite
- 2) Electro slag. welding
- 3) Resistance stud welding
- 4) Induction welding
- 5) Light radiation. welding
- 6) Laser welding
- 7) Arc image. welding
- 8) stud welding
- 9) Arc - stud welding.

Types of welding joint.

1) Butt joints:

This type of joint provide the least inherent stresses and strains in welding, the lowest consumption of the base and deposited metals and the shortest welding time sheets of the same or different thickness can be abutted.

2) Tee joints:

This type of joint is obtained when the end face of one member is joint to the other in the form of a 'T'. The vertical member edges may be unbevelled or one or two of its edges may be bevelled.

3) Corner joints:

In such a joint, the end face of one member to be fitted up is tacked to the end of the other member surface, thus forming a right obtuse, or acute angle. A corner joint is a special case of a 'T' joint.

(4) Lap joints: When the surface of one member to be assembled is superimposed on the surface of the other one, a lap joint is formed.

(5) Plug (or slotted) lap joints: A variety of lap joints are joint which are made when the length of a normal weld fails to assure the required strength.

(6) Edge joint: A weld in edge joints is applied to the end faces of sheets to be assembled which are arranged at one level.

(7) Strapped joints: Such a type of joint is reduced when they cannot be substituted by butt or lap joints in comparison with which an additional metal consumption is required for straps.

Oxy-Acetylene gas welding.

Oxy-acetylene gas welding is accomplished by melting the edges or surface to be joined by gas flame and allowing the molten metal to flow together, thus forming a solid continuous joint upon cooling. This process is particularly suitable for joining metal sheets and plates having thickness of 2 to 15 mm. With material thicker than 15 mm, additional metal called filler metal is added to the weld in the form of welding rod. The composition of the filler rod is usually the same or nearly the same as that of the part being welded. To remove the impurities and oxides present on the surfaces of metals to be joined and to obtain a satisfactory bond, a flux is always employed during the welding except mild steel which has more manganese and silicon that act as deoxidizing agents.

Oxy-acetylene principle with diagram of oxy-acetylene setup:

Oxy-acetylene welding is known as fusion welding process. The coalescence of metal is formed by an oxygen-acetylene flame. Excessive heat is concentrated on the border or on the edge and surface of the pieces of metal being connected until the molten metal flows jointly. A filler material is used to whole the residue by the type of joint purpose. Filler metals are added by inserting it into the molten puddle of the bottom metals the puddle after solidifying forms the weld bead. The very high heat depends on the combination of two types of gaseous matter, oxygen, and acetylene. Oxygen supports higher burning, acetylene being the fuel for burning. Welding is made easy if surfaces are clean and freed from foreign matters by wire brushing or else machining impurities may lead to failing in a weld, due to which metal may be filled by gas or slag inclusion.

Types of flames.

1) Neutral flame:

A neutral flame has two definite zones:

- (i) a sharp brilliant cone extending a short distance from the tip of the torch, and
- (ii) an outer cone or envelope only faintly luminous and of a bluish colour. The first one develops heat and the second protects the molten metal from oxidation, because the oxygen in the surrounding atmosphere is consumed by the gases from the flame.

2) Carburizing Flame:

It is one in which there is an excess of acetylene. The flame has three zones:

- (i) The sharply defined inner zone.
- (ii) an intermediate cone of whitish colour.
- (iii) the bluish outer cone. The length of the intermediate cone is an indication of the proportion of excess acetylene in the flame. When welding steel, this will tend to give the steel in the weld a higher carbon content than the parent metal, resulting in a hard & brittle weld.

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3) Oxidising flame:

An oxidising flame is one in which there is an excess of oxygen. This flame has two zones: (i) the small inner zone which has purplish tinge and

(ii) the outer cone or envelope. In the case of oxidising flame, the inner cone is not sharply defined as that of neutral or carburizing flame. This flame is necessarily for welding brass. In steel, this will result in a large grain size, increased brittleness with lower strength and elongation.

Gas welding equipments:

1) welding torch:

This is a tool for mixing oxygen and acetylene in correct proportion and burning the mixture at the end of a tip. These are generally of two types — (i) equal pressure (ii) injector type.

(2) Welding tip: It is that portion of the welding apparatus through which the gases pass just prior to their ignition and burning. There is a good variety of interchangeable welding tips, differing in size, shape & construction.

(3) Pressure regulator: The functions of a pressure regulation are to reduce the cylinder pressure to the required working pressure and also to produce a steady flow of gas regardless of the pressure variations at the source.

(4) Hose and hose fittings:

The hose for welding torches should be strong, durable, noncombustible and light. The most common method of piping both

oxygen and acetylene gas in the reinforced rubber hose.

(5) Gas cylinders:

Oxygen gas in cylinders are usually charged with 40 litres of oxygen at a pressure of about 154 kgf/cm².

(6)

Filler Materials.

A filler material is a metal added in the making of a joint through welding, brazing or soldering. Four types of filler metals exist - covered electrodes, bare electrodes wire or rod, tubular electrode wire, and welding fluxes. Sometimes non consumable electrodes are included as well, but since these metals are not consumed by the welding process, they are normally excluded.

Principle of Arc welding:

The source of heat in an arc welding is an electric arc. The arc column is generally generated between an anode, which is the positive pole of dc power supply, and the cathode, the negative pole. When these two conductors of an electric circuit are brought together and separated for a small distance (2 to 4 mm) such that the current continues to flow through a path of ionized particles, called plasma, an electric arc is formed. This ionized gas column acts as a high resistance conductor that enables more ions to flow from the anode to the cathode. Thus, electrical energy is converted to heat energy. The heat of the arc raises the temperature of the parent metal which is melted forming a pool of molten metal. The electrode metal or welding rod is also melted and is transferred in the metal in the form of globules of molten metal. The deposited metal serves to fill and bond the joint or to fuse and build up the parent metal surface. The blast of the arc forces the molten metal out of the pool, thus forming a small depression in the parent metal, around which molten metal is piled up. The arc is extinguished

by widening the arc sufficiently.

ARC welding Setup & Equipments with diagram :-

The setup consists of a rectangular steel tank mounted on three-typed wheels, the front wheel swivelling and steerable by means of a draw bar. An oil-cooled, double wound step down transformer reduces the supply mains voltage to a welding voltage of 80. All windings are totally enclosed in the steel tank. The output of the transformer can be varied by rotating a hand wheel which alters the air gap in the core of the choke resulting in stepless regulation of the current between 50 & 400 amp. The welding current setting can be directly read at the window of the top corner. The set can be connected to two lines of 400/440 volts, 3-phase 50 a.c supply; it requires about 109 litres of class 2 transformer oil.

Equipments:

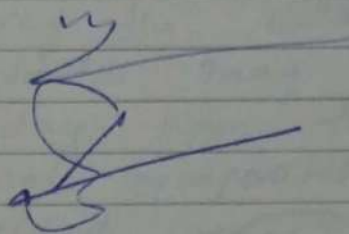
- (i) ac or dc machine
- (ii) electrode

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- (iii) electrode holder
- (iv) cables, cable connectors.
- (v) cable lug.
- (vi) chipping hammer.
- (vii) earthing clamps.
- (viii) wire brush
- (ix) helmet
- (x) safety goggles
- (xi) hand gloves.
- (xii) aprons, sleeves, etc



Arc welding Tools:

1) Electrodes: Both consumable and non-consumable electrodes are used for arc welding. Non-consumable electrodes are made of carbon, graphite or tungsten which don't consume during the welding operation. Consumable electrodes may be made of various metals depending upon their purpose and the chemical composition of the metals to be welded. The consumable electrodes may be bare or coated.

(2) Electrode holder:

Commonly called a slinger is a clamping device for holding the electrode securely in any position. The welding cable is attached to the holder through the hollow insulated handle.

(3) Flux:

In welding, the primary purpose of flux is to prevent the oxidation of base and the filler materials. Flux is a substance which is nearly inert at room temp. but which becomes strongly reducing at elevated temp. preventing the formation of metal oxides. Additionally, flux allows solder to flow easily on the working piece rather than forming beads as it ~~would~~ otherwise.

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(4) Eye shield:

Eye shields are very important in welding as it protects the eye from harmful heat and ultraviolet and infrared rays.

(5) Chipping hammer:

A chipping hammer is a tool used to remove welding slag from a weld.

(6) Wire brush:

After using the chipping hammer, the wire brush is used to remove the slag and impurities and undesired particles from the workpiece.

(7) Gloves:

Gloves are used to protect the hand from the heat.

Aim: BUTT JOINT by arc DTP.

Job Diary

SL.No.	Name of Job	Materials used	Tools and equipment Used	Time	Obtained Time	Remarks
4	Butt joint	Mild steel plate	Steel scale, shop saw, heck saw, table vice, filler, flat file, tongs, chipping hammer, helmet, electrode holder, T-square, steel brush, anvil	3 hrs	3 hrs.	
<u>OPERATIONS INVOLVED.</u>						

- Measuring: Steel foot rule is used to measure the metal plate
- Marking: marking is done at 71 mm using scriber.
- Cutting: we cut the plate using chapsaw.
- Filing: flat file is used to obtain 70 mm plate.
- Setting: done with help of T-square

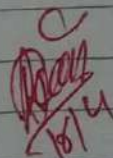
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- tacking: done by joining both the ends
- welding: done with electric arc welding
- chipping: done with help of chipping hammer
- cleaning: done with the help of steel brush
- cooling: it is left undisturbed for natural cooling.

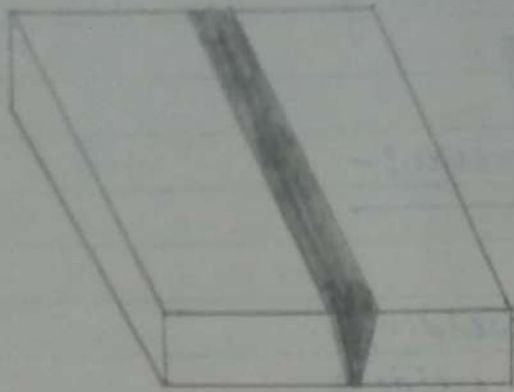
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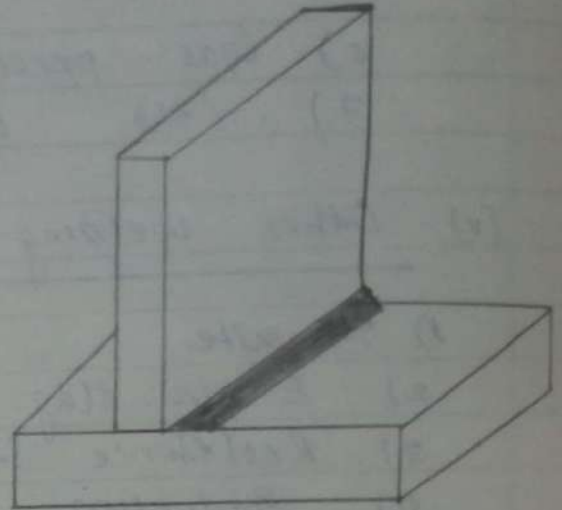
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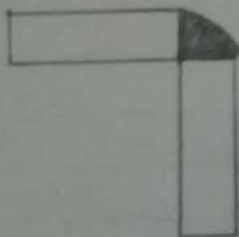
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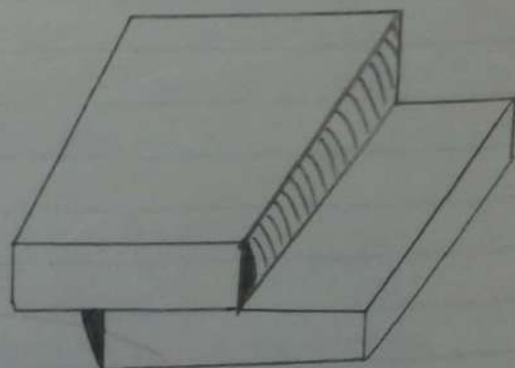
Butt joint



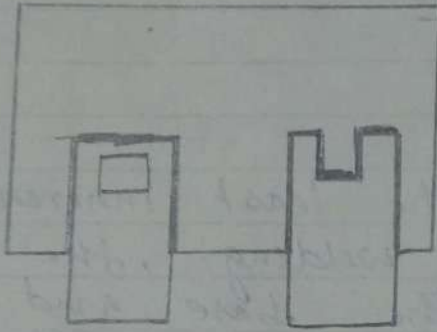
Tee joint



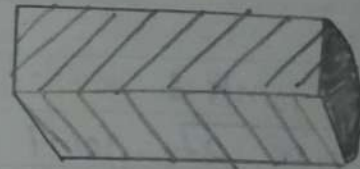
Corner joint



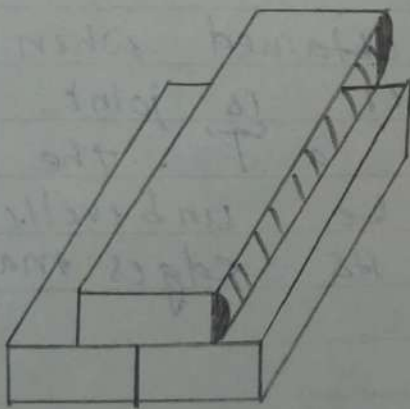
lap joint



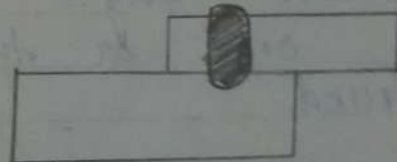
Plug joint



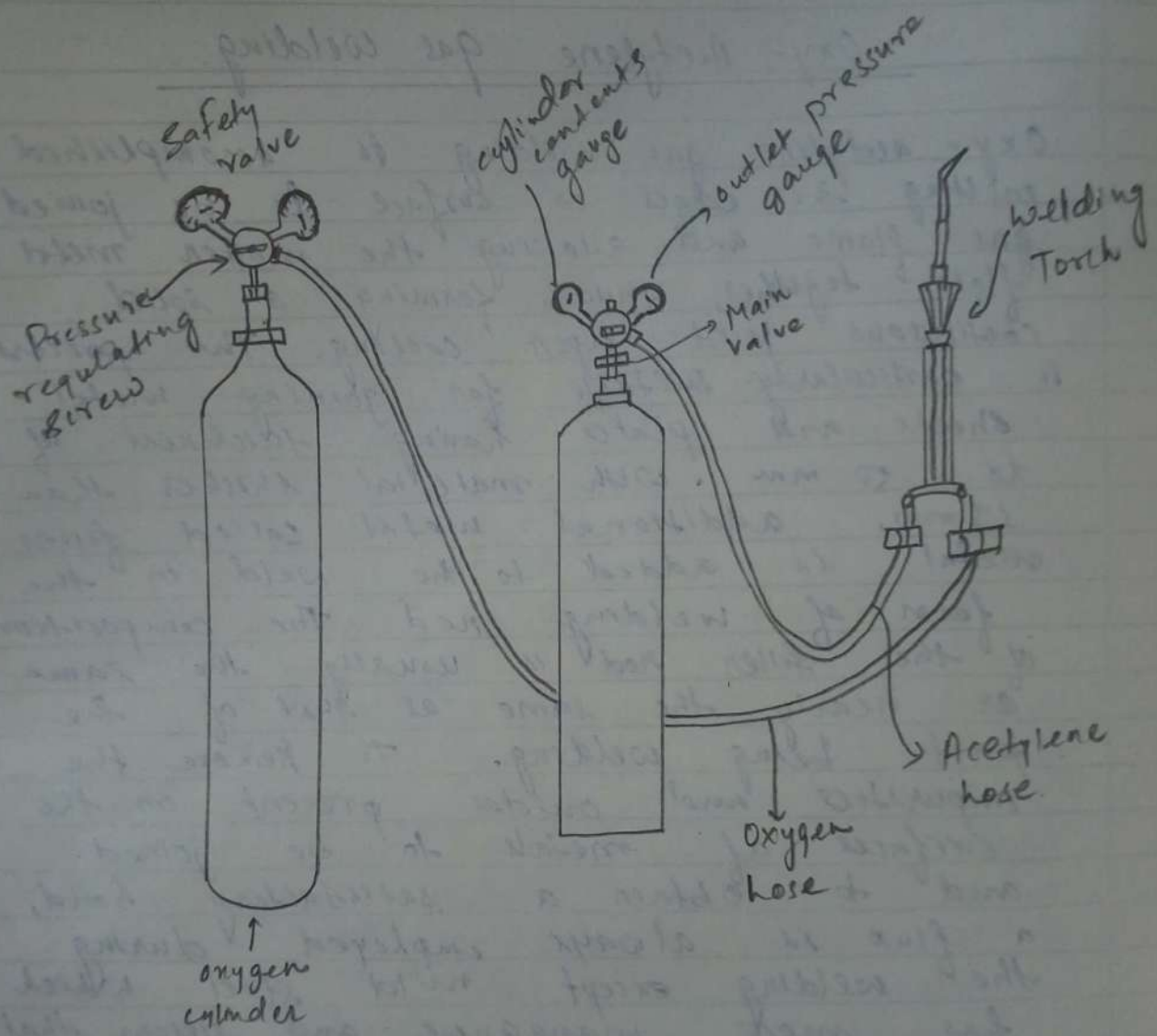
Edge joint



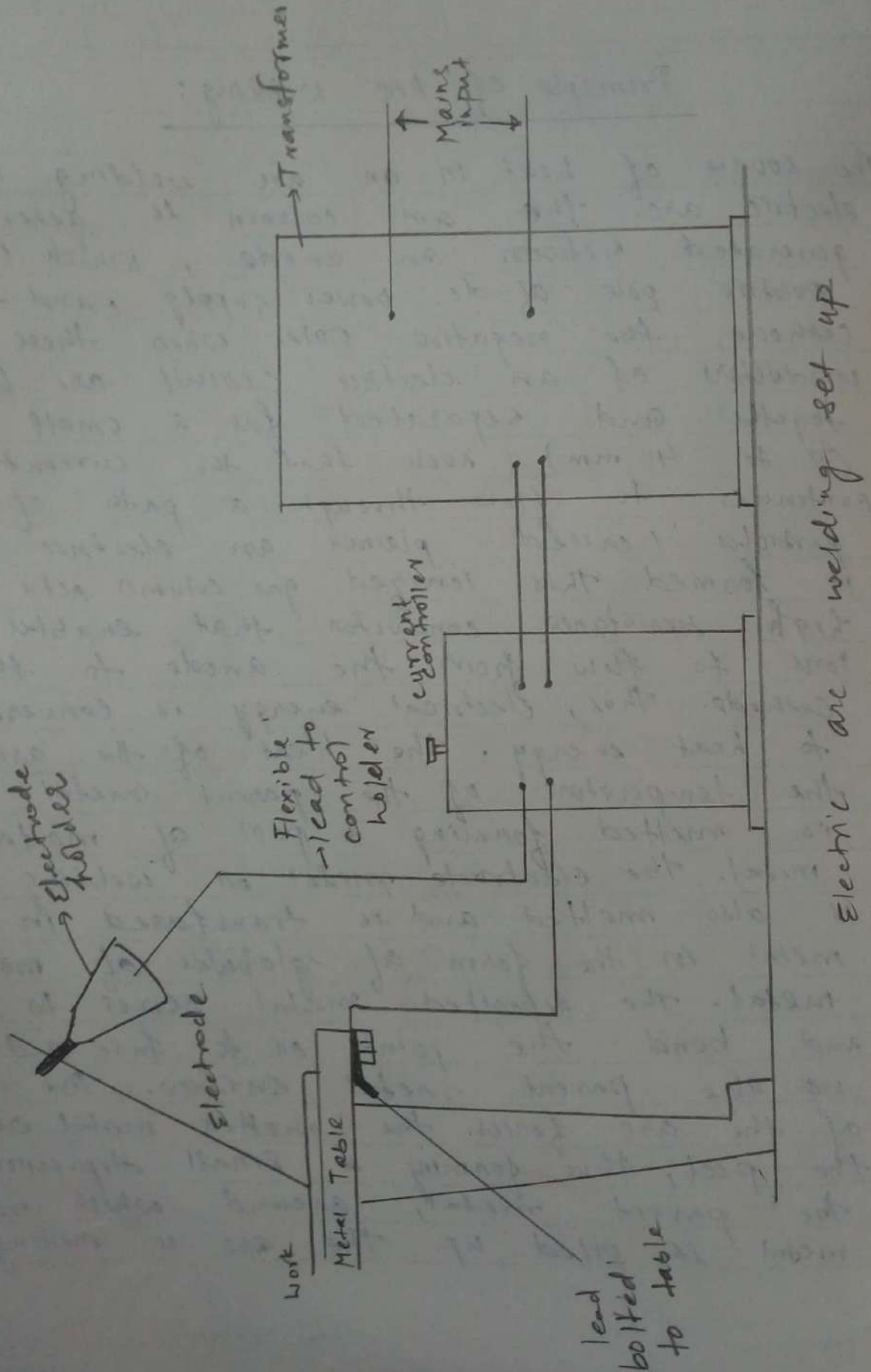
Strapped joint



Plug weld joint

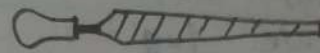


Oxy - Acetylene welding set

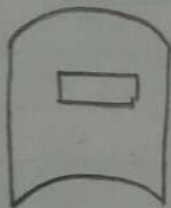




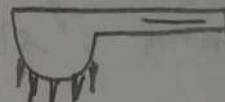
Electrode



flat file



Helmet



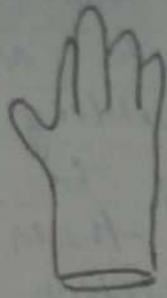
wire brush.



chipping hammer



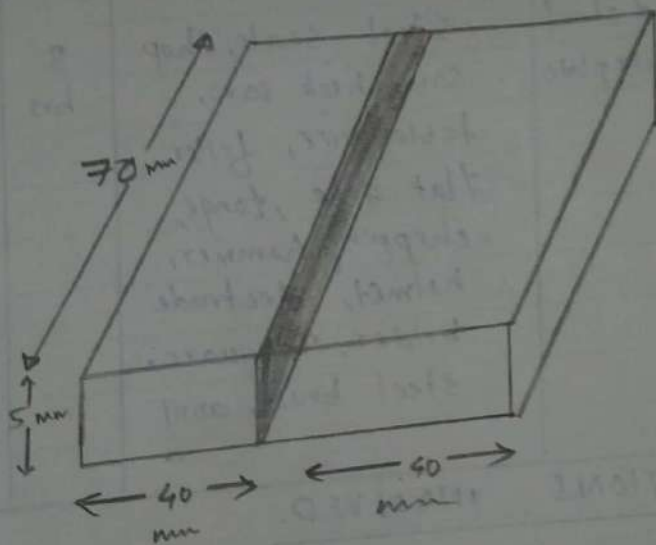
electrode holder



Gloves



Blow pipe



WELDED JOINTS



(A) BUTT JOINTS. THIS TYPE OF JOINT PROVIDES THE LEAST INHERENT STRESSES AND STRAINS IN WELDING, THE LOWEST CONSUMPTION OF THE BASE AND DEPOSITED METALS, AND THE SHORTEST WELDING TIME. SHEETS OF THE SAME OR DIFFERENT THICKNESS CAN BE ABUTTED.



(B) TEE JOINTS. THIS TYPE OF JOINT IS OBTAINED WHEN THE END FACE OF ONE MEMBER IS JOINED TO THE SURFACE OF THE OTHER IN THE FORM OF A 'T'. THE VERTICAL MEMBER EDGES MAY BE UNBEVELLED OR ONE OR TWO OF ITS EDGES MAY BE BEVELLED



(C) CORNER JOINTS. IN SUCH A JOINT THE END FACE OF ONE MEMBER TO BE FITTED UP IS TACKED TO THE END OF THE OTHER MEMBER SURFACE, THUS FORMING A RIGHT OBTUSE, OR ACUTE ANGLE. A CORNER JOINT IS A SPECIAL CASE OF A TEE JOINT.



(D) LAP JOINTS. WHEN THE SURFACE OF ONE MEMBER TO BE ASSEMBLED IS SUPERIMPOSED ON THE SURFACE OF THE OTHER ONE, A LAP JOINT IS FORMED.



(E) PLUG (OR SLOTTED) LAP JOINTS. A VARIETY OF LAP JOINTS ARE (OR SLOTTED) LAP JOINTS WHICH ARE MADE WHEN THE LENGTH OF A NORMAL LAP WELD FAILS TO ASSURE THE REQUIRED STRENGTH.



(F) EDGE JOINT. A WELD IN EDGE JOINTS IS APPLIED TO THE END FACES OF SHEETS TO BE ASSEMBLED WHICH ARE ARRANGED AT ONE LEVEL.



(G) STRAPPED JOINTS. SUCH A TYPE OF JOINTS IS REALIZED WHEN THEY CANNOT BE SUBSTITUTED BY BUTT OR LAP JOINTS IN COMPARISON WITH WHICH AN ADDITIONAL METAL CONSUMPTION IS REQUIRED FOR STRAPS.



(H) PLUG WELD JOINT. IN THIS JOINT THE MEMBERS TO BE WELDED ARE OVERLAPPED AND THE TOP SHEET IS DRILLED ALONG THE JOINT WELD LINE AT SEPARATE POINTS. THE OPENINGS ARE REWELDED. AS A RESULT, A STABLE BOND WITH THE BOTTOM SHEET IS FORMED. PLUG WELD JOINTS FEATURE GOOD STRENGTH WITH THE WELD DENSITY BEING RATHER LOW.