UNIT- 4 Metal Joining (welding)

welding :- The welding process Joins two pieces of metal By applying intense heat or pressure or both to melt the edges of the metal so that they fuse permanently. The Joined formed is a permanent Joint In welding filler material may be also used. The heat required for the process of welding can be obtained by using an electric arc, electric current gas flame or chemical reaction the process is done with or without the application of Pressure.

Gas welding :- The most common gas welding process is oxyfuel welding also known as oxyacetylene welding. Acetylene when burned with oxygen can produce a temp of about 3250°C making Acetylene ideal for welding & cutting. An oxy- Acetylene outfit is portable, less expensive and more versatile than and electric welding set up By using proper tips rod any metal can be welded it is widely used for welding the roof, pipe and tubes of well as repair work also.

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Gas welding Equipment

1- Cylinders - oxygen and Acetylene are stored under pressure in steel cylinder.

2- Oxygen Cylinders :- These cylinders are made of steel and are usually painted green.

3- Acetylen Cylinders :- These cylinders are contain Acetylene under pressure are painted Black.

4- Regulators :- It Regulate the pressure Both two high pressure & low pressure.

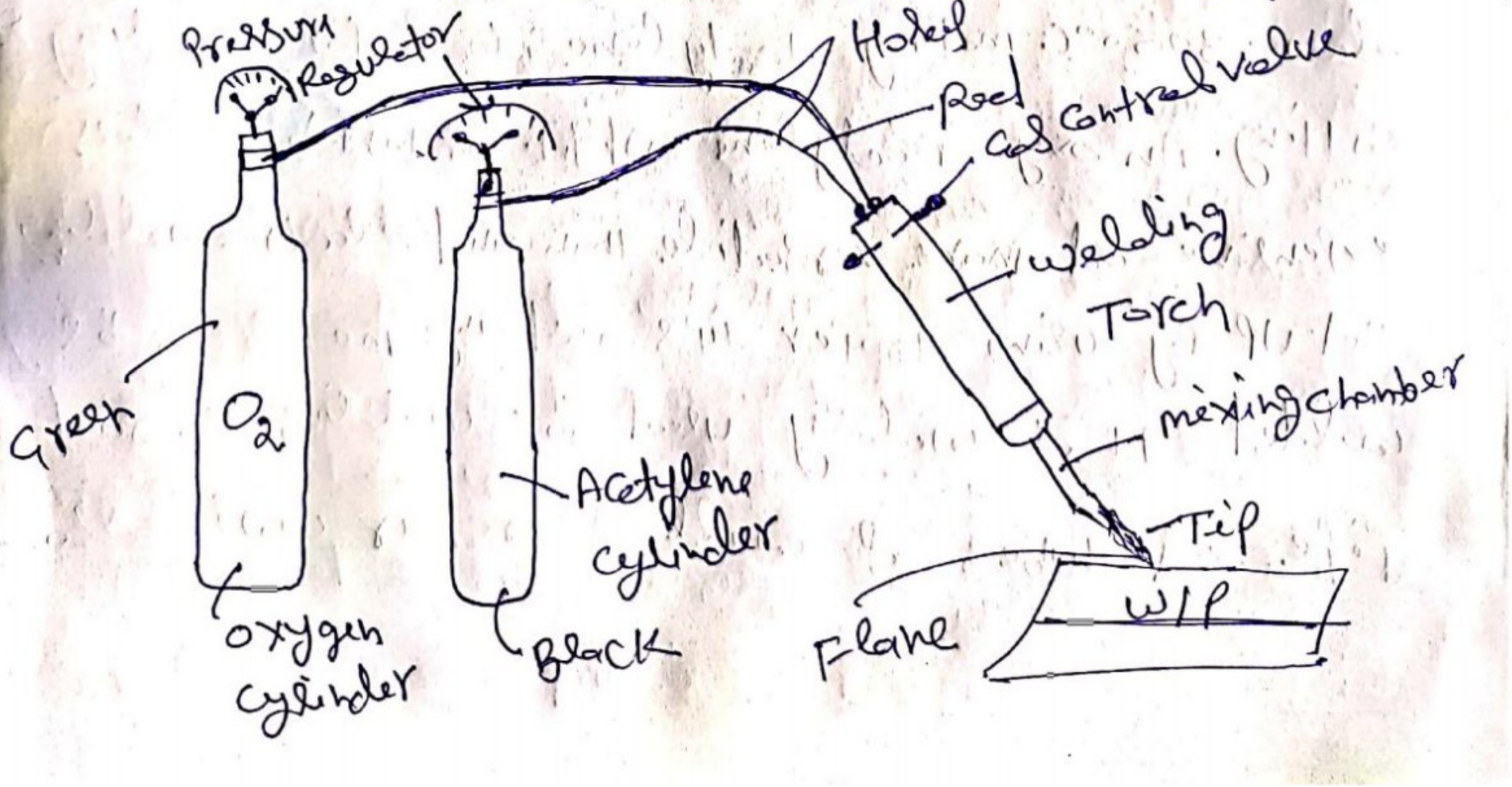
5- Welding Hoses ⇒ To mix the gases & Travel allow

6- Check Valve ⇒ To regulate the gases

7- Flash Back arrestors ⇒ Burning the fuel

8- Torches ⇒ for mixing the gases

9- welding & cutting tips ⇒ for Weld & cuts.



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Working Process :- the oxyacetylene flame of the welding set

Procedel develops an extremely high temp at it bright inner core useful for melting metals and permits the welder to protect with the flame itself and with its surrounding envelop the metal molten puddle from neighboring air which allows in, would oxidize the metal and impair the weld properties

Gas cutting :- A cutting attachment connects to the end of the torch handle in place of the welding tip arid allows for the cutting of metal upto 8 inches thick for cutting metal over 8 inches the use of a cutting torch instead of a cutting attachment should be used. the fuel gas valve on the torch handle is used to adjust the fuel.

cutting Torch :- the cutting torch is connected to the hoses in place of the welding handle and is used for cutting thicker metal that can be cut with the cutting attachment or for heavy duty cutting work.

" The common method used in cutting metal are oxygas flame cutting air carbon arc cutting and plasma arc cutting. The method depend on type of metal cuts and availebilety of equipments. the oxygen

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cutting torch have many work in steel industries at most Naval activities.

when using oxygen gas cutting process a spot is heated on the metal to the kindling or ignition temp (between 1400°F to 1600°F) for steel. The torch this oxy flame is preheating flame. Then jet of pure oxygen is directed at the heated metal by pressing a lever on cutting torch. when oxygen oxydation occur rapidly it is called combustion or burning. when is it occur slowly called

Advantages of Gas welding

1- process is versatile
2- Adapted to many different Jobs
3- portable
4- self sufficient
5- Independent from availability of external energy sup

Disadvantages

1- Skill welder required
2- process is much slower than arc welding
3- flux required for most material

Application of Gas welding

1- For joining thin material
2- For joining Ferrous & Non ferrous material
3- used in aircraft & sheet metal industry
4- used in cutting.

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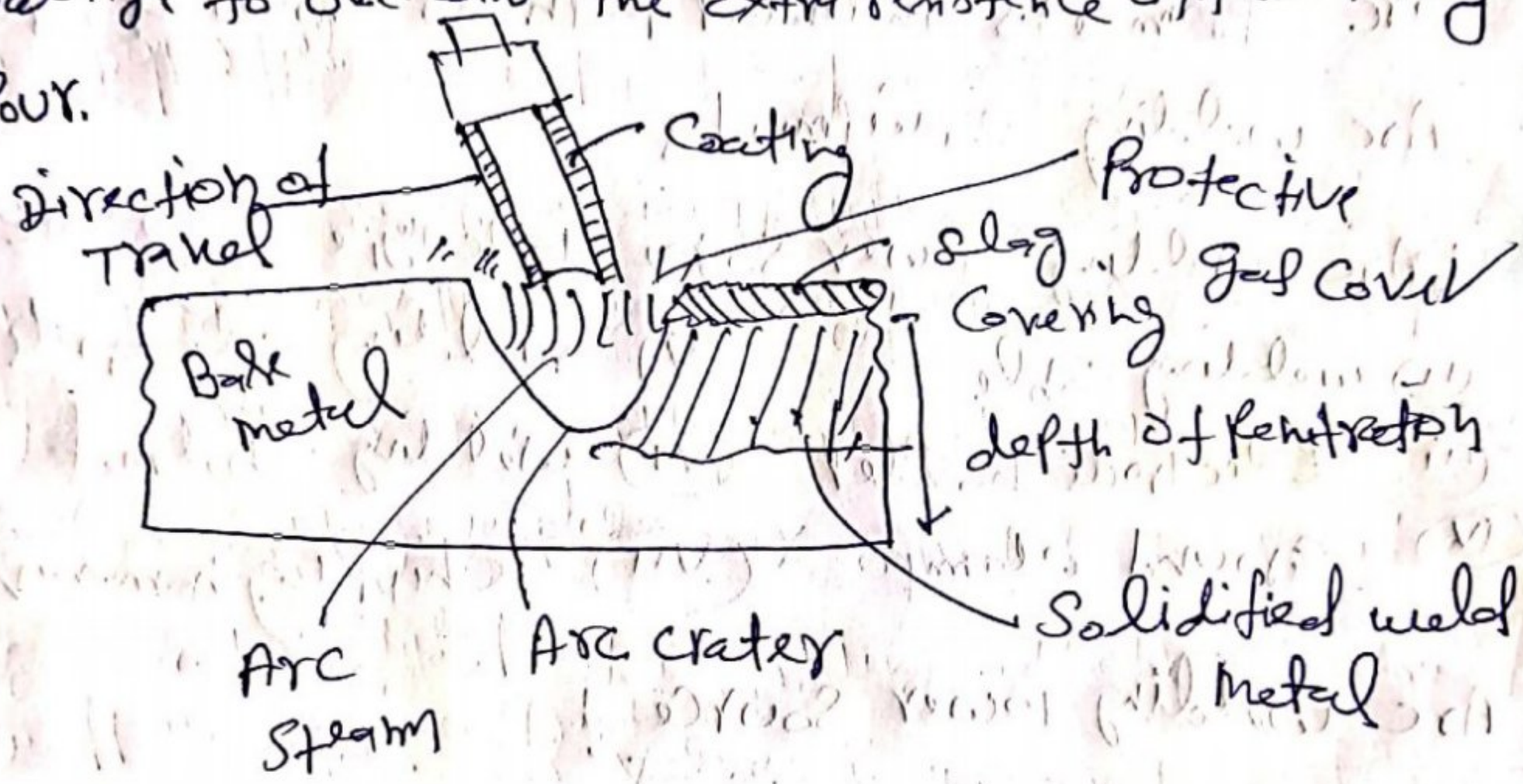
Arc welding :- The principal of arc welding consists of establishing an electric arc b/w a metal electrode and the workpiece to be welded the arc can be described as a stream of incandescent vapour which acts as a conducting medium for electric current from one terminal to the other to complete the circuit the electric current has a fairly high voltage to overcome the extra resistance offered by the vapour.



The process is illustrated by the schematic diagram the metal of the workpiece to be joined is called Base metal or parent metal and that provided by the electrode as filler metal the metal electrode is coated with flux which perform the following actions.

1- It produce a gas which provides a shield around the arc to protect it from atmosphere.

2- It forms slag by mixing with impurities of the molten metal

3- The slag being lighter, floats over the surface of molten metal and on solidification forms a thin layer.

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Arc blow :- It is a typical characteristic of DC arc welding, which is normally not found when using AC. During DC arc welding it is often observed that the arc fluctuates occasionally or it unstable. It is due to magnetic forces. The deflection of the arc from its intended path is known as Arc blow.

Arc welding Equipments

(I) Arc welding power source 1- AC Type 2- DC Type
(II) welding cable
(III) Electrode holder
(IV) ground clamp
(V) welding electrode
(VI) welding helmet
(VII) chipping hammer brush.

Arc welding power source :-

An Arc welding power source is designed to change high voltage low amperage current into a safe low voltage (between 50 and 100 volts) heavy current supply (generally 500 amp). Suitable for welding power source is required to supply the current that supports the arc column for fusion welding.

The Power sources used to supply the electric current for arc welding can be divided into three categories.

(a) Those that supply direct current DC. motor generator sets diesel engine driven, generators & Transformer Rectifier sets.

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b- Those that supply alternating current AC transformers and AC generators.

C- AC|DC arc welder combinations supplying either AC or DC such power sources are AC Transformers with DC Rectifiers

Arc welding Advantages

1- Straight & Reverse Polarity can be employed to advantage
2- welding can be carried out in All the Positions.
3- Nearly all ferrous & Non ferrous metal can be welded.
4- Generator output is not affected by Normal variation in Power line voltage.

Disadvantages

1- High initial cost
2- Highly maintenance cost
3- Noisy machine operation.

TIG (Tungsten inert gas welding) :- Tig is an electric arc welding process which produces an ARC b/w a non-consumable tungsten electrode and work to be welded TIG is used very commonly in area such as rail car m/f, automotive & chemical industry. The process is also known as Gas Tungsten Arc welding.

Moreover in this process the fusion energy is produced by an electric arc burning b/w the work piece & tungsten electrode during this welding process the electrode the arc & weld pool are protected against the damaging effect of

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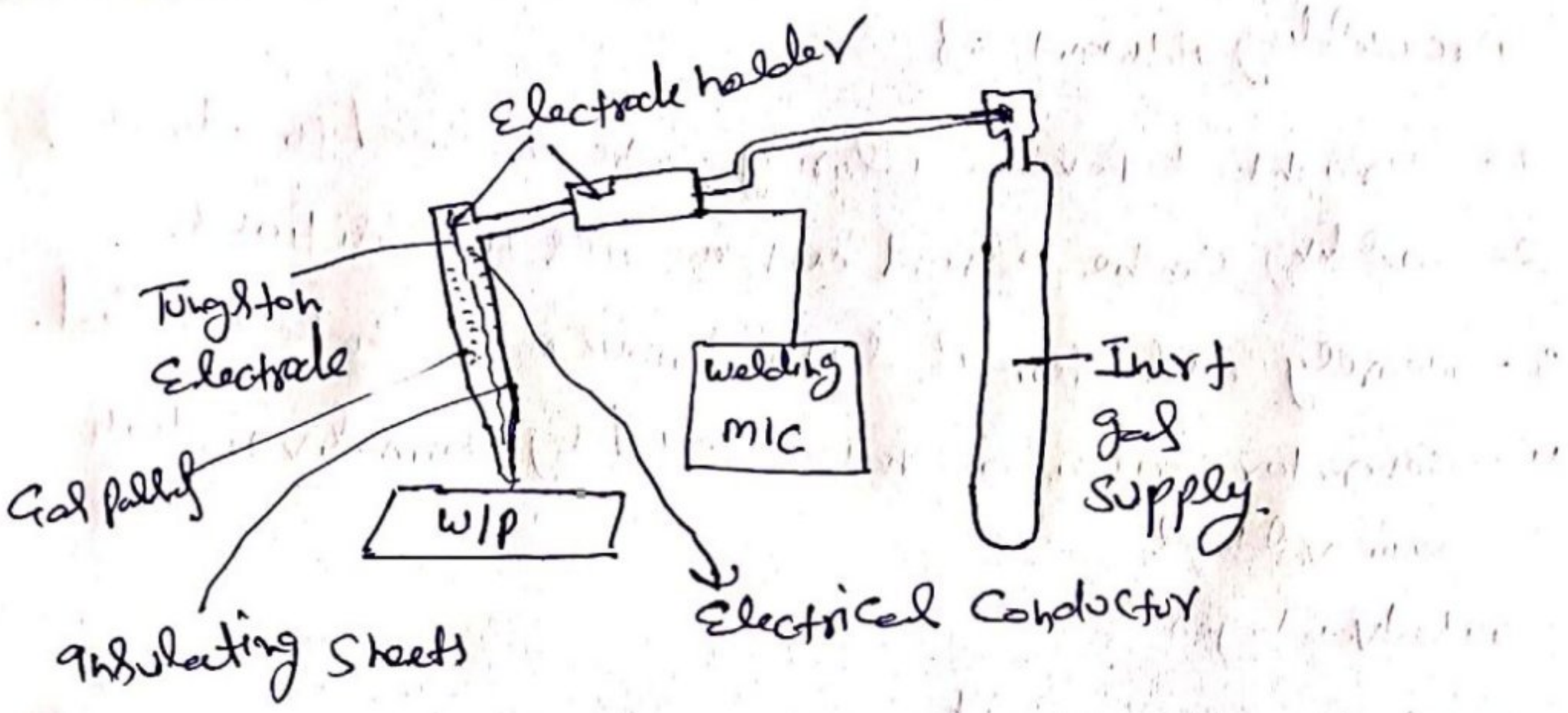
Atmospheric air by an inert shielding gas By means of gas Nozzle the shielding gas is lead to the welding zone where it replace the atmospheric air Actually in this Focal Arc is stock b/w Non Consumable tungsten Electrode & the Base metal.



Equipment :- 1- welding power sources, 2- welding torch
3- Inert gas cylinder 4- cooling water supply

Inert Gases used in TIG :- ARGON - Mostly used in All metals
HELIUM - Pure helium used for Al & Cu alloy
Helium Argon mixture, Argon Hydrogen mixture

Working Principal :- In this Coalescence is Reduced by heating the w/p with an electric arc Stick The electric discharge is generated a plasma Arc b/w the electrode tip and the w/p to be welded The arc is initialized by a power source with high frequency generator The are generate high temp approx 6100C & melts the surface of weld metal to form a Molten Pool Inert gas avoid Atmospheric Pool. As the molten metal cools coalescence occurs & the parts are joined.

Advantages :-

1- No flux is used so No danger of flux entrapment
2- Because clear visibility the operator can exercise better control in welding.
3- very suitable for high ductility thin material
4- good process for weld non ferrous material.

Disadvantages :-

1- Tungsten inclusion is hard & Brittle
2- Inert gas shield cause weld metal contamination
3- Equipment cost high.

Applications

- welding Aluminium, magnelium, Copper, Nickel & their alloy & Hard material.
- welding sheet metal & thin section
→ Precision welding of Atomic energy
→ - Rocket motor chamber welding in Launch vehicle.

MIG - (Metal inert gas welding) :- metal inert gas welding also known as metal Arc welding (MAG) is a welding process that is widely used for welding a variety of material ferrous & Non ferrous. The essential future of the process is the small diameter electrode wire which is feed continuously into the arc from a coil As a result this process can produce quick & neat welds over a wide range of joints.

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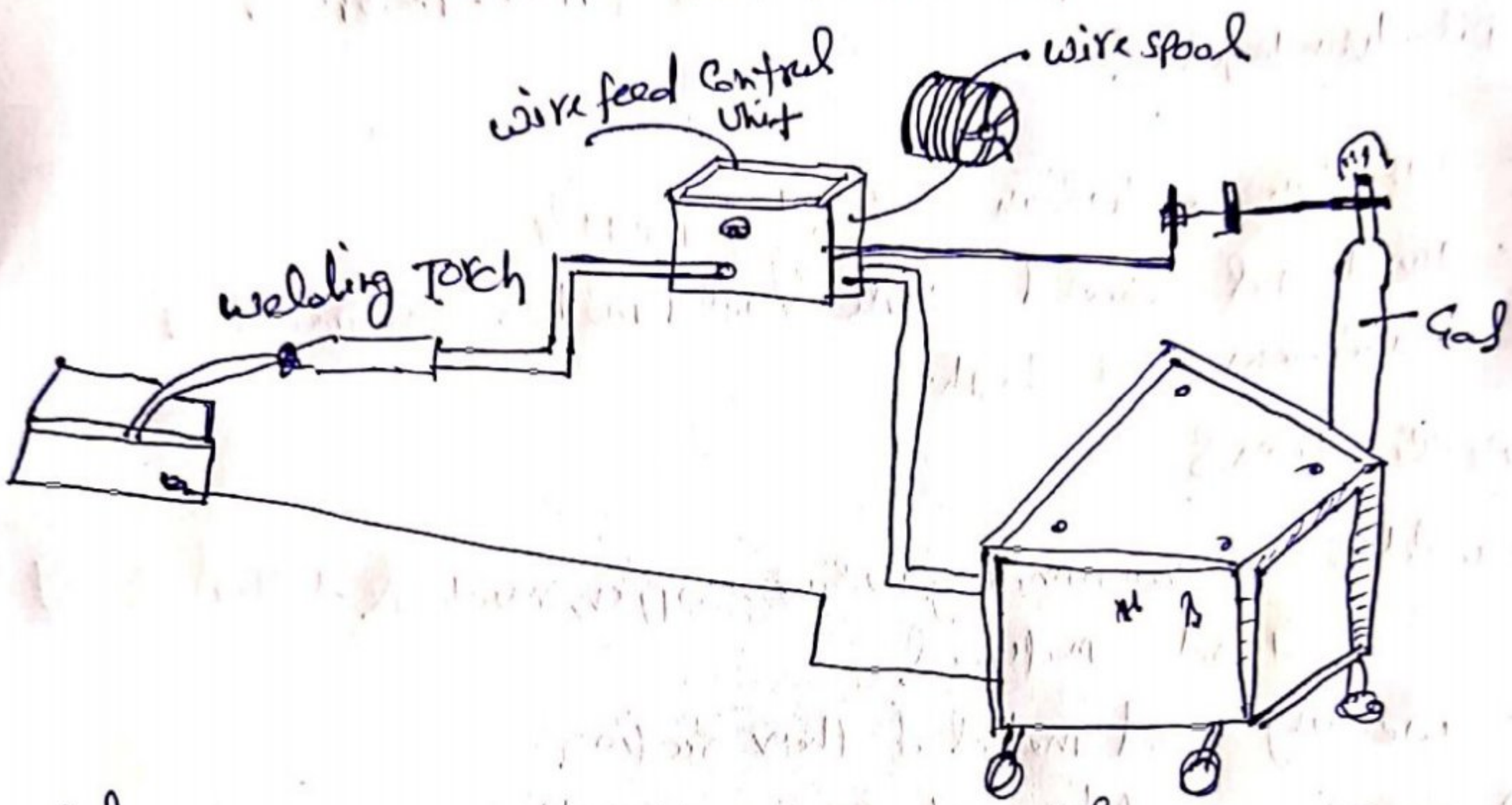
Equipment :- ① Dc output power source
② wire feed Unit
③ TOURCH ④ wor Retorn welding lead
⑤ shielded gas supply.

shielding gas
1- Pure Carbon dia oxide
2- argon oxygen mix



metal gnert or Arc welding uses the heat generated by a DC electric Arc to to fuse the metal in the Joint are the arc bing struck blw a Continusly fed Consumable filler wire and the work piece melting Both the filler wire & W/P in the immediate vicinity

Power Sourc

application

1- used for Automotive repair
2- Rebuilding Equipment
3- overlay of wear resisting
4- welding of Pipel.

Resistance welding (RW) :- Resistence welding is one of the oldest of electric welding procels in use by industry today. It refers to the group of welding procelses. The weld is made by a combination of heat, Pressure and time. As the Name Resistence welding implies, it is the resistence of the material to be welded to current flow that causes a localized heating in the part. In this procels the generated Heat is proportional to the product of resistence by the square of current and by time.

$$H = I^2 R t$$

H = Heat generated I = current in ampere
R = Resistence t = flow time of current in second

Types of Resistance welding :-

- Resistance welding
  - Spot
  - Seam
  - Projection

Resistance Spot welding :- Spot welding is a type of resistance welding used to weld various sheet metals typically in the .5 - 3 mm thickness range. The procels uses two shaped copper alloy electrodes to concentrate welding current & force b/w the material to be welded the result is a small spot that is quickly heated to the melting point

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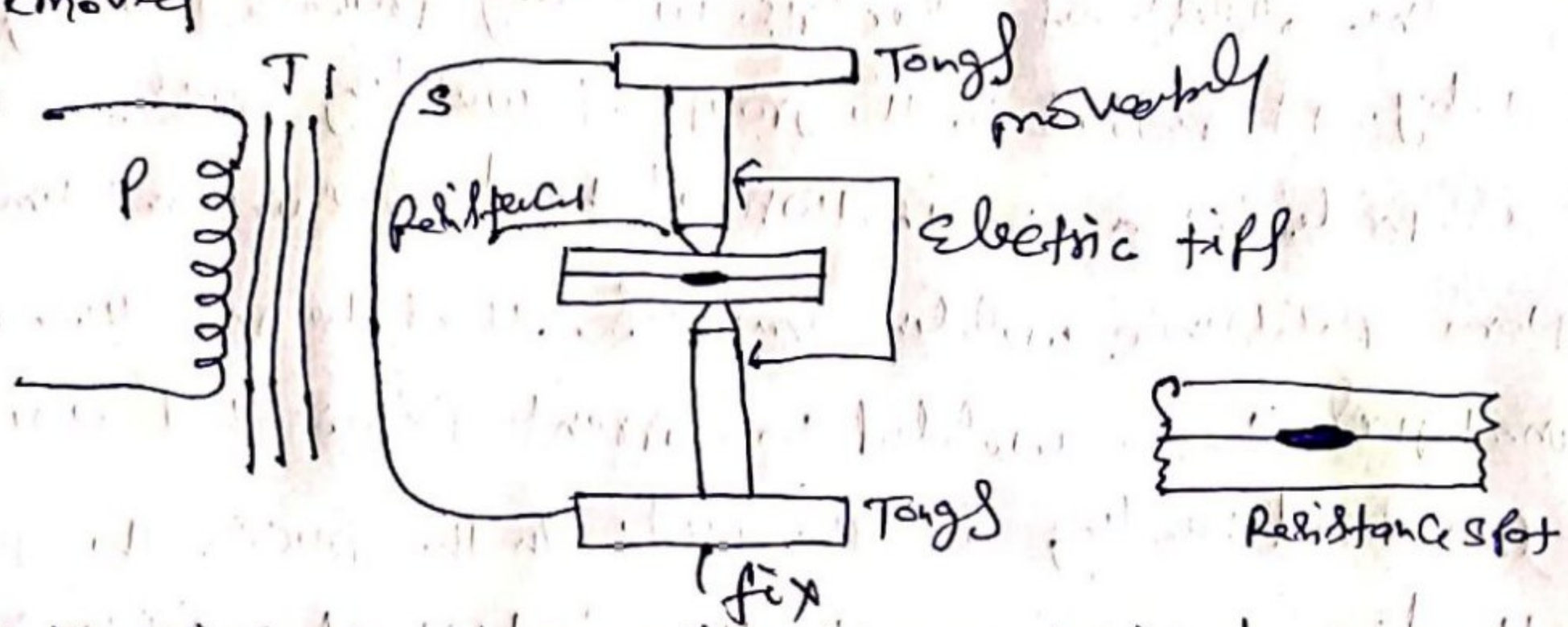
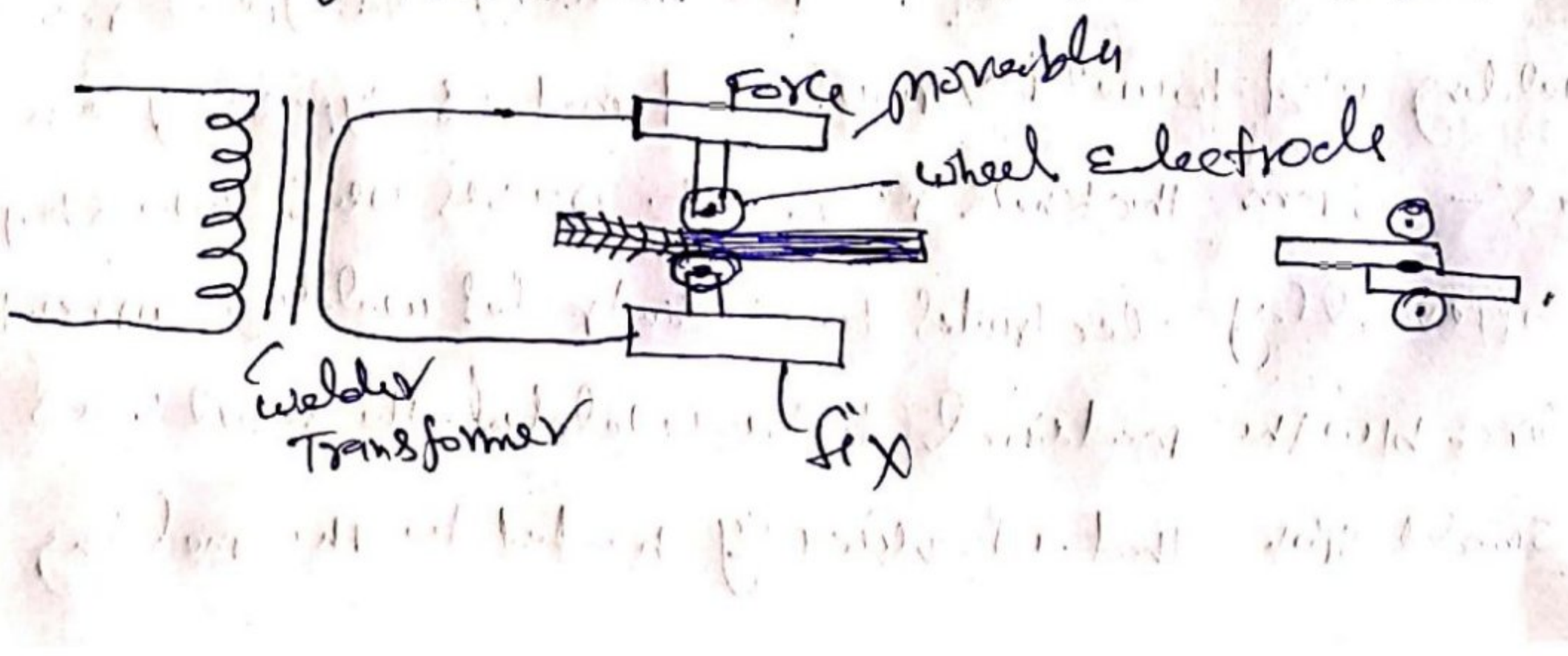
forming a nugget of welded metal after the current is removed



working + Resistance spot welding is accomplished when current is caused to flow through electrode tips and the separate pieces of metal to be joined. the resistance of the build metal to electrical current flow causes localized heating in the joint and the weld is made.

Resistance seam welding + Resistance seam welding is a resistance welding process which produces coalescence at the faying surfaces because of the heat obtained from resistance to electric current through the work parts held together under pressure by electrodes. the resulting weld is a series of overlapping resistance spot welds made progressively along a joint rotating the electrode IN seam welding a rather complex control system is required.



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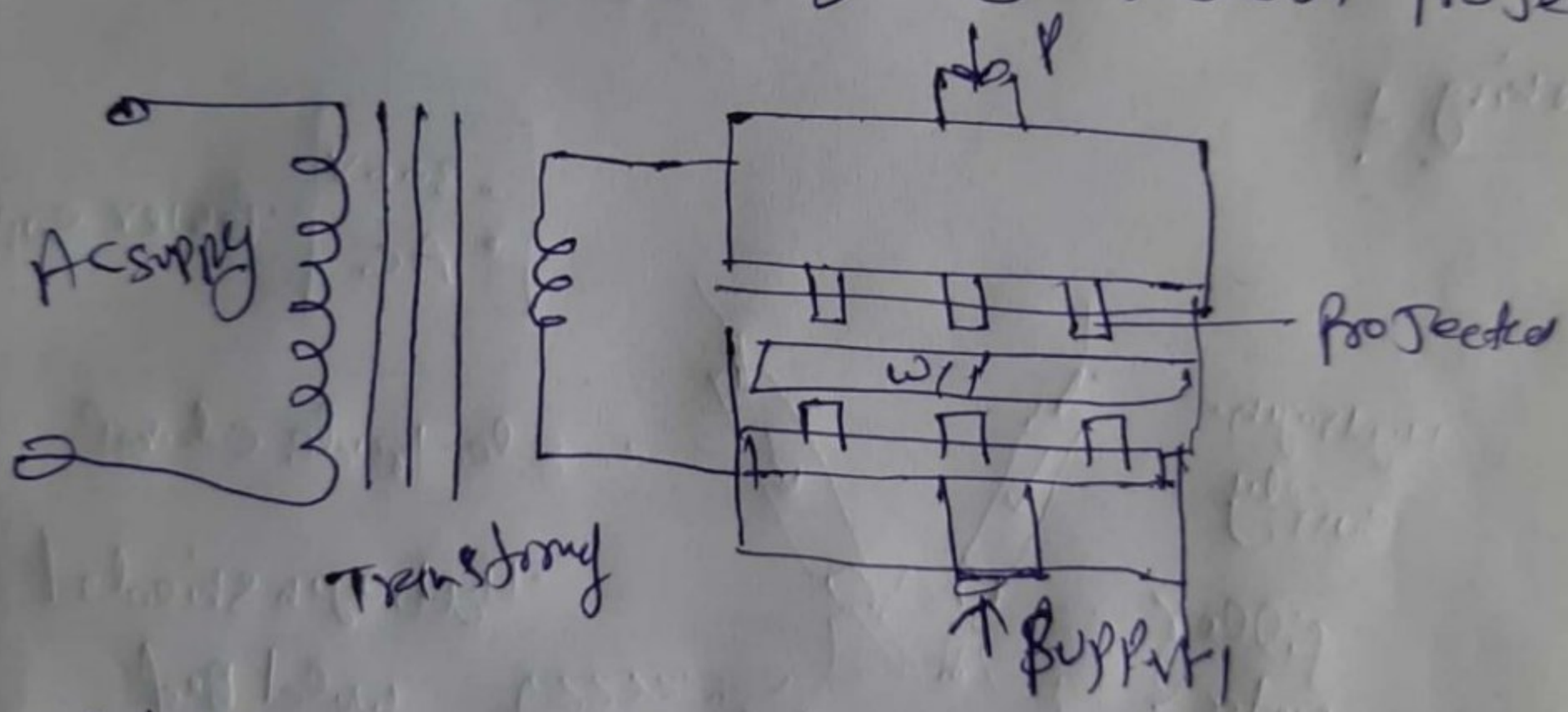
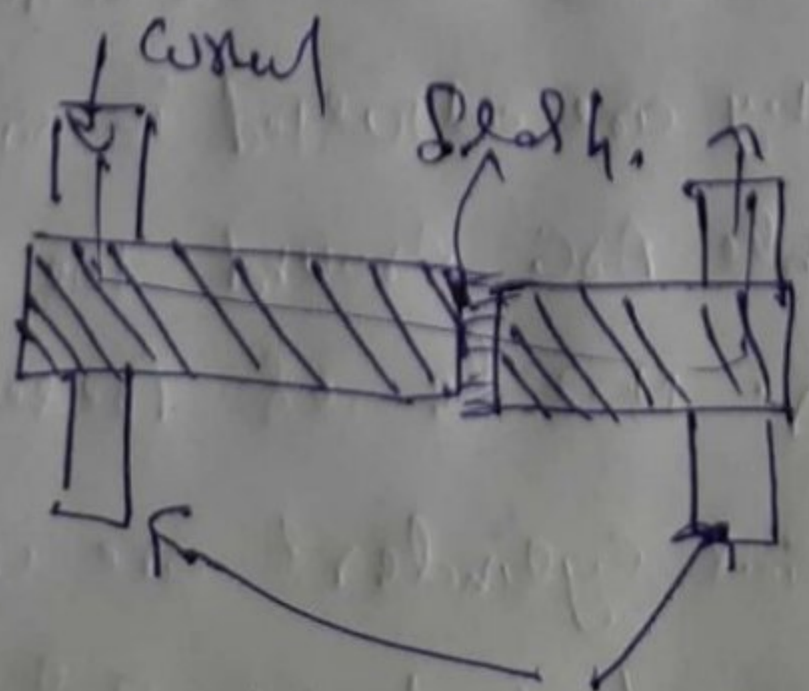
Resistance Projection welding → Projection welding is a another variation of spot welding. Small projections are raised on one side of the sheet or plate with a punch die. The projections act to localize the heat of the welding circuit. During the welding process the projections collapse owing to heat & pressure & the parts to be joined are brought in close to contacts. The several types of projections are (i) dome type (ii) elongated projection (iii) ring projection (iv) shoulder projection (v) Cross wire welding (vi) radial projections



Flash welding → Flash welding is a resistance welding process which produced coalescence simultaneously over the entire area of abutting surfaces.



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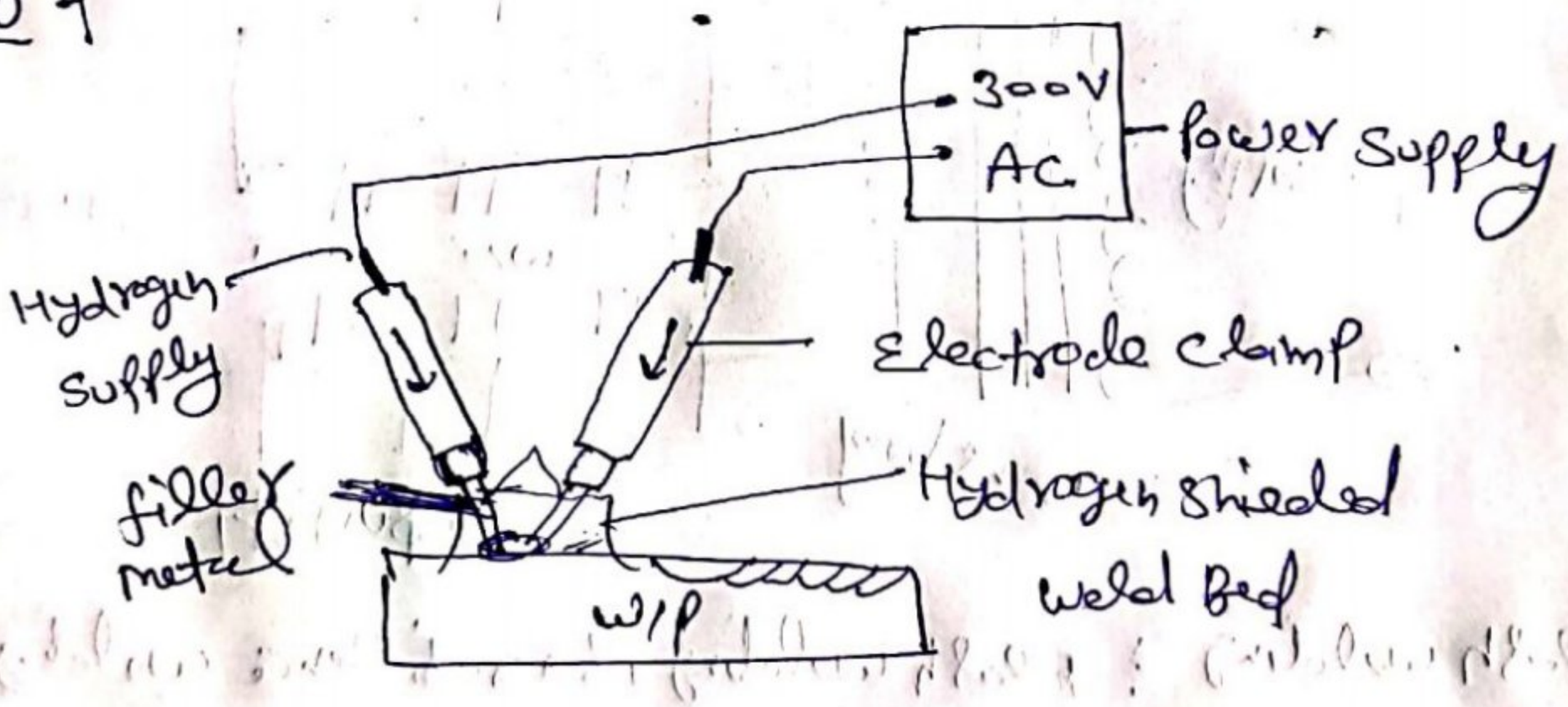
Atomic Hydrogen welding :- It is an Arc welding process that uses an electric arc between two tungsten electrode in the presence of Hydrogen the shielding Atmosphere in the atomic. Hydrogen welding process is abbreviated as AHW.

Equipments :- 1- Two electrodes of tungsten
2- An electrode holder or touch
3- Hydrogen Gas cylinder
4- Filler rod metal
5- A Controller with 300 V power supply.

Working :-



The equipment involved in the AHW, contains a welding torch with two tungsten electrode this two electrodes are inclined to each other also they are adjusted in such a way that they will maintain a stable Arc Around the two tungsten electrodes an angular Nozzle is present which carries the Hydrogen gas. Gas cylinders are used for the storage of the required hydrogen gas.

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Arc generation takes place when two electrodes of tungsten are kept in contact with each other Also After making the contact they are separated by a small distance of 1.5mm when the electric arc Passes through the hydrogen gas it dissociated into the atomic hydrogen this dissociation into the atomic hydrogen happens due to the absorption of a large amount of heat produced on the Process. Here the endo thermic Reaction takes Place After that the recombination of the atomic Hydrogen takes Place. this recombination takes Place as the atomic Hydrogen touchs the cold workPiece.

factor Affect A.H.W

1- Speed of Travel 2- Arc Size

3- starting setting of current 4- Contact of W/P with Arc

Advantages :- 1- A.H.W Produced very less distortion at Concentrated area Particular Joint

2- A.H.W gives a Faster welding Process

3- IN A.H.W there are Not required of the flux

4- there are No Problem of Striking the Arc

Disadvantages :-

1- required a Skilled Labour.

2- Cost is slightly higher.

3- Limited to only Flat Position weld.

Application :-

1- weld fast for Stainless Steel & Some alloy

2- weld for ferrous & Non ferrous

3- weld for thick Sheet of metal dia 2-10 mm.

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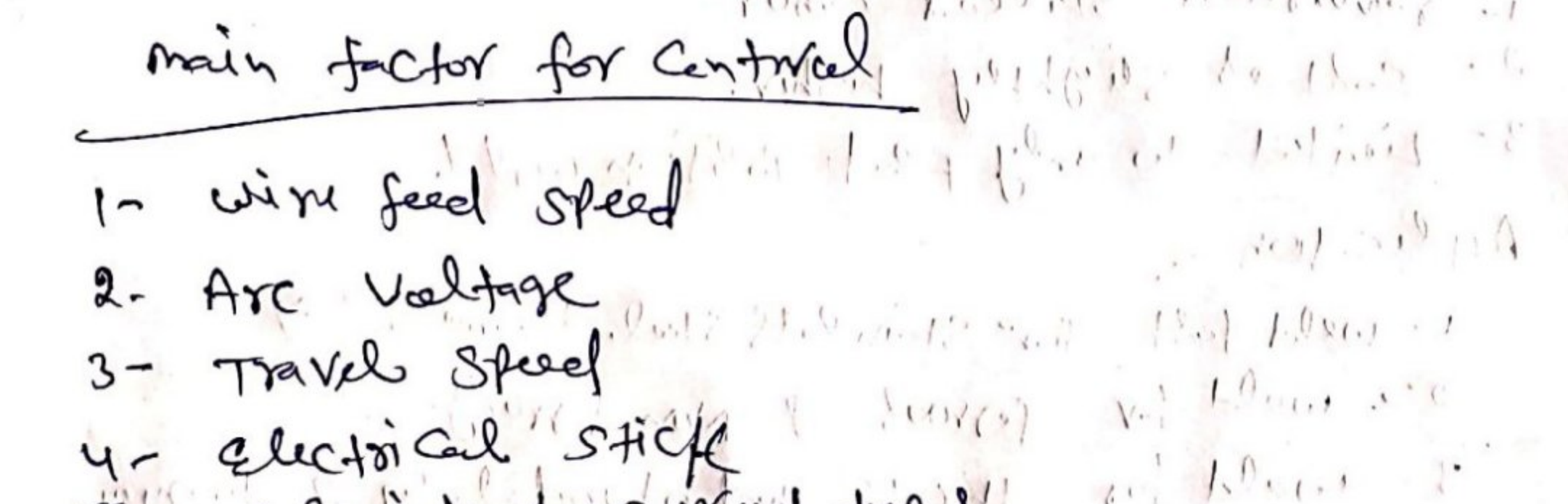
Submerged Arc welding ⇒ Submerged Arc welding is defined as "an Arc welding process which produces coalescence of metals by heating them with an Arc or arcs b/w a bare metal electrode or electrodes and the work piece. Pressure is not used and filler metal is obtained from the electrode and sometime from a supplementary welding rod shielding is obtained from a blanket of granular flux which is fed directly over the weld area. The flux close to the arc melts and intermixes with the molten weld metal and helps purify and fortify it. The flux forms a glass like slag that is lighter in weight than the diposited weld metal and floats on the surfaces as a protective cover. The weld is submerged under this layer of flux & slag hence the Name Submerge Arc.



SAW Normaly operated in the automatic or in the mechanized mode.

main factor for Control

1- wire feed speed
2- Arc Voltage
3- Travel Speed
4- Electrical stick
5- polarity & current types.

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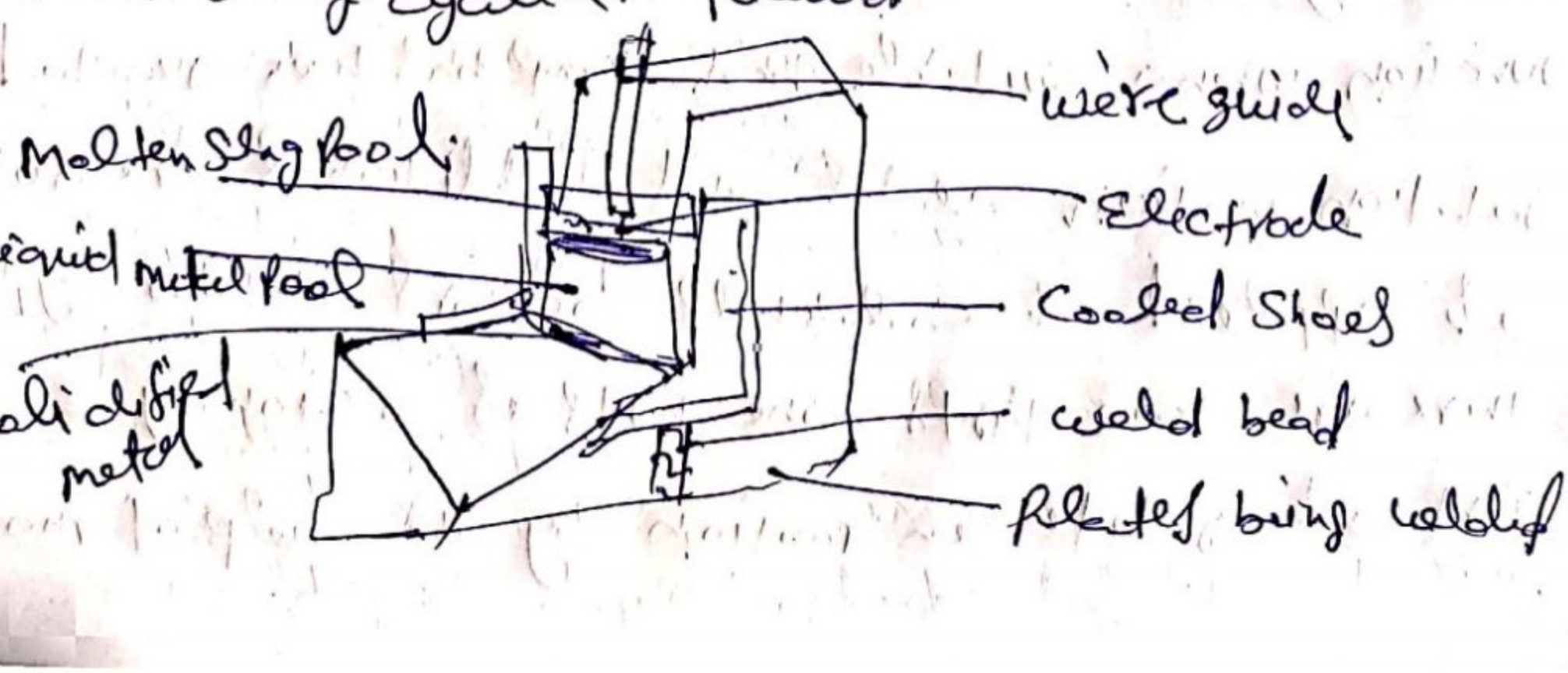
Advantages of SAW

1- Very high current can be used.
2- High deposition rate
3- Deep weld penetration
4- Process is thermally efficient

Disadvantages

1- Since the weld can not be seen
2- It is largly limited to flat position
3- overhead Not possible
4- Not suitable for metal less than 7.92 mm thick..

Electroslag welding :- Electroslag welding was developed in the 1950s. It is used to fuse two sections of thick metal The process of electroslag welding is a vertical uphill process Two copper shoes, dams or mould must be placed on either side of the joint that is to be welded in order to keep the molten metal in the joint area. one or more electrodes are fed into the weld joint almost vertically from special wire guides it contain a flux and an ac power source that has approximately 1000 amperes output and a 100 percent duty cycle are needed



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Electroslag welding depends upon the generation of heat that is produced by passing an electrical current through molten slag the space formed b/w the molten slag pool into which the electrodes are immersed. The current passing through the base metal & electrodes heats the metal to a high temp.

Advantages of E.S.W :-

1- It is Automatic process
2- Joint preparation is not required
3- Process can be used for welding Hot rolled steel

Disadvantages :-

1- Electroslag welding can weld to thickness of 12-250mm
2- Cost is high.

Friction welding :- Friction welding is a solid state welding process which produces coalescence of material by the heat obtained from mechanically induced sliding motion b/w rubbing surfaces the work parts are held together under pressure this process usually involves the rotating of one parts against another to generate friction heat at the junction when a suitable high temp has been reached rotation motion ceases and additional pressure is applied & coalescence occurs. It Four types there are two parts one part is stationary & other part is rotated in motion by the help of motor

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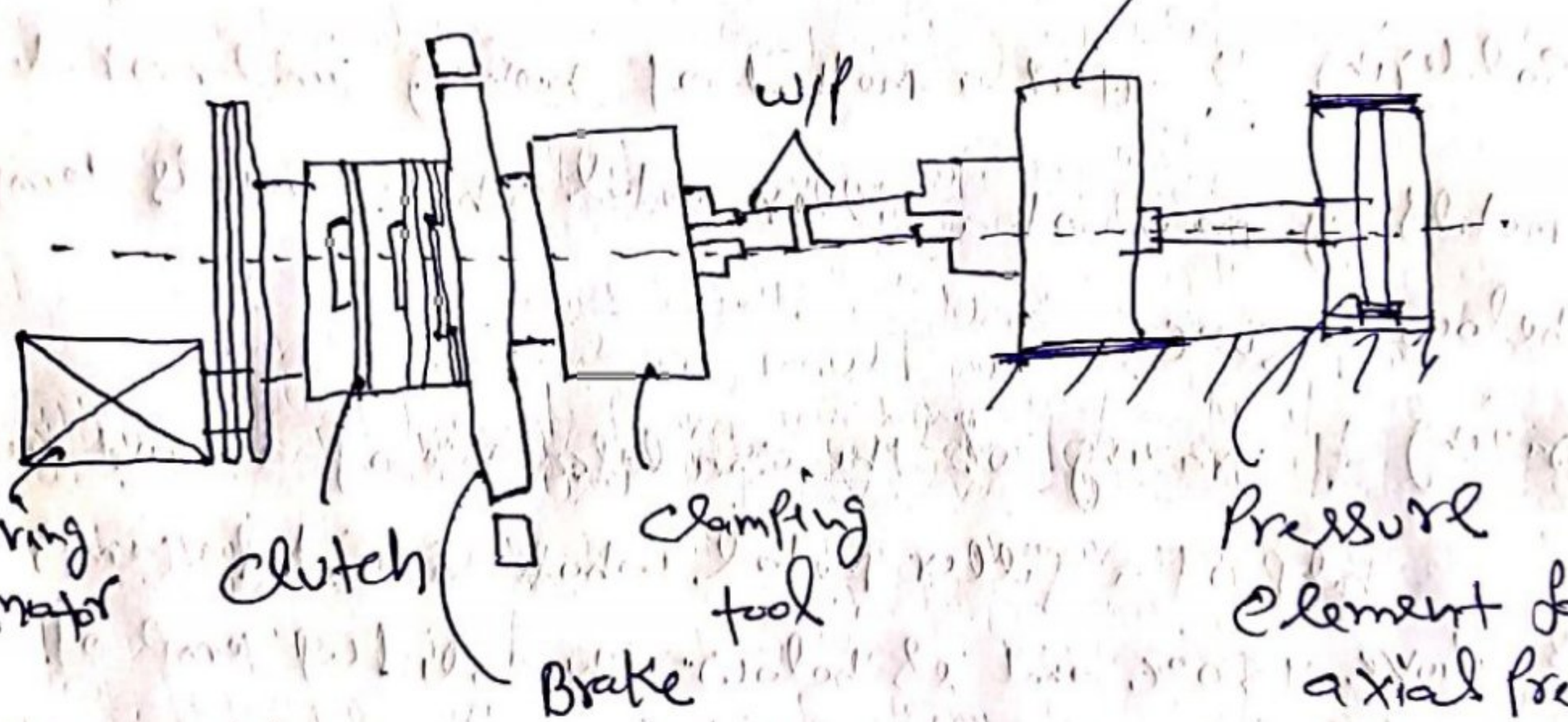
Four types

1- Spin welding 2- Rotary Friction welding

3- Linear friction welding 4- Friction Stir welding

Working ⇒

Two parts have one rotation and one stationary & the parts brought in contact under pressure for specified period of time with a specific pressure for a specified period of time with specific pressure Rotating power is disengaged from the rotating piece and the pressure is increased when the rotating piece stop the weld is completed



Advantages :

① The Procell is relatively clean
② Produce high Quality welds in a short cycle time
③ there is No widespread softening of the alloy
④ weld entire area in a single shot.
⑤ Good Mechanical Joint
⑥ Heat affected zone is very narrow.
⑦ Can Join many material combination.

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Disadvantages :-

1- Limited aleligned for Uniaxle
2- High equipment & tooling cost
3- only mechanized procell pollible
4- Produces upset Flash.

Application :- Used in variety of industries aerospace automotive, cryogenic, electrical machinary.

(2) Friction welding of a forged part to a simple bar.

Soldering :- it is a method of Joining similar or dissimilar metals by means of a filler metal whole liquids temp is below 450°C.

Brazing :- Brazing is the coalescence of a Joint with the help of a filler metal whole liquidus temperature is above 450°C and is below the solidus temp of the Base metal The filler metal is drawn into the Joint by means of capillary action (Entering of fluid into tight fitted surfaces) Because of the lower temp used there is less distortion in brazed Joints. The colour of the filler metals in the brazed Joint also may not match with that of the Base metal.

IN. Brazing Joint need to be extremely cleaned Any grease or oil present in the Joint prevents the flow

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of filler metal. Hence the joints should be thoroughly cleaned using proper solvents the flow of filler metal oxides and scales present are removed by acid pickling Fluxes are added into the brazed joint to remove any of the oxide present or prevent the formation of the oxides.

It Boiler Combination of 75% borax & 25% boric acid the filler metal used copper alloys having zinc 7%. Some time silver Brazing for high Strength. Used.

Heat Affected Zone (HAZ) :- The heat affected zone is within the Base metal itself it has a micro structure different than that of the Base metal before welding. It has been subjected to elevated temp for a period of time during welding. The portion that are far away not structural changes during welding the properties depend on (i) The rate of heat input & cooling and

(ii) The temp to which this zone had been raised during welding.

The Strength & hardness of the heat affected zone depends on how the original strength and hardness of the particular alloy were developed prior to to welding partially. They may have been developed by cold working solid solution,

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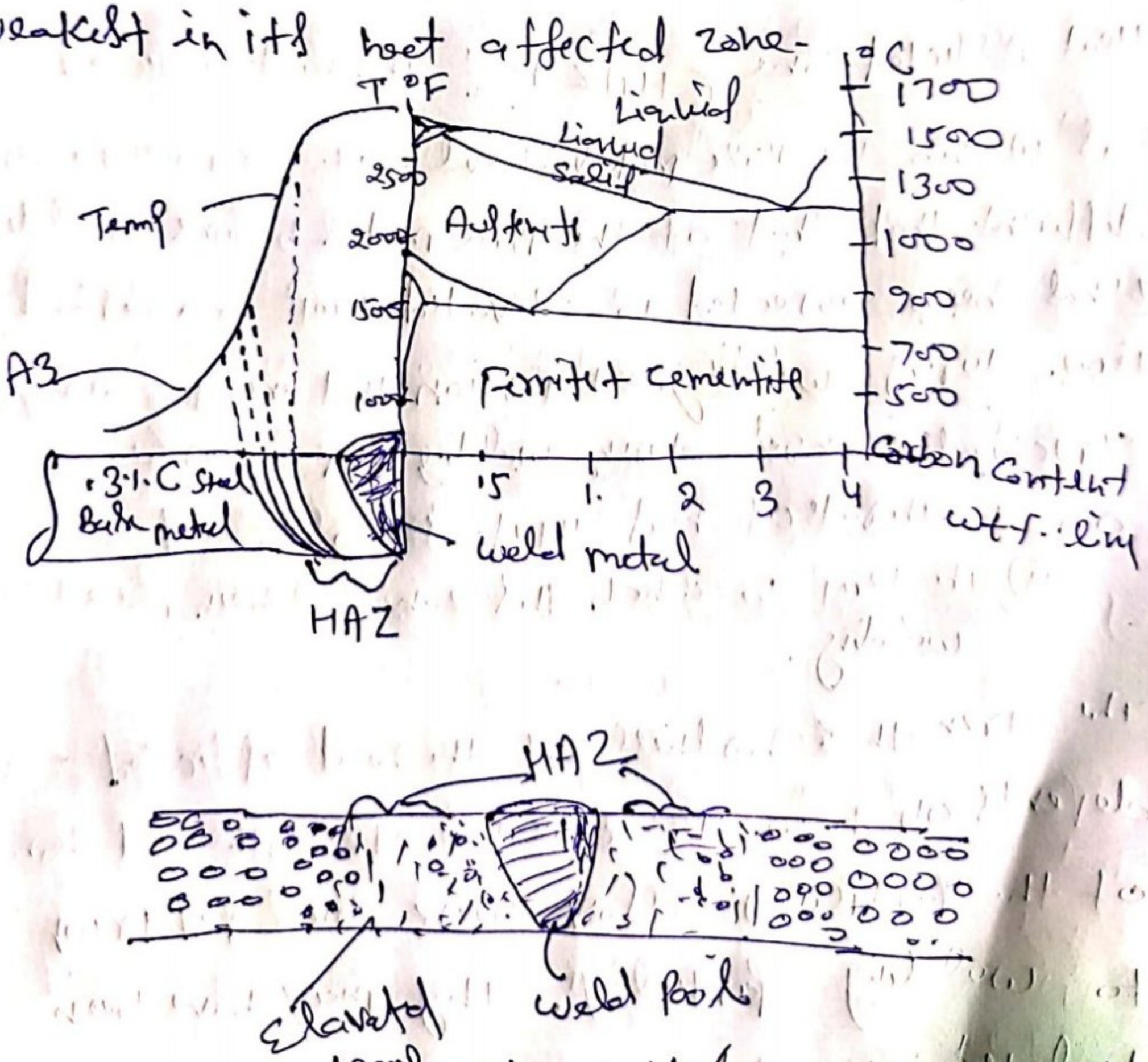
Strengthing precipitation hardening or various heat treatment.

The heat applied during welding recrystallisation of the elongated grains of the cold worked Base metal.

Grains that are away from the cold metal will recrystallize into fine equiaxed grains. However grains close to the weld metal having been subjected to elevated temp for a long period of time will grow this grain growth will result in a region that is softer and has less strength and such a joint will be weakest in its heat affected zone-



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