12.12.19

CHAPTER-1

ELECTROLYTIC PROCESS

ELECTROLYTE

It is a substance which get desolved into ions when electric current will flow through it.

ELECTROLYTIC PROCESS

→ The process of decomposition of electrolyte by the passes of electric current is called electrolytic process

ELECTRO DEPOSITION / ELECTRO PLATING

→ The process of deposition of metal over the surface of another metal by the process of electrolysis is called electro deposition or electro plating.

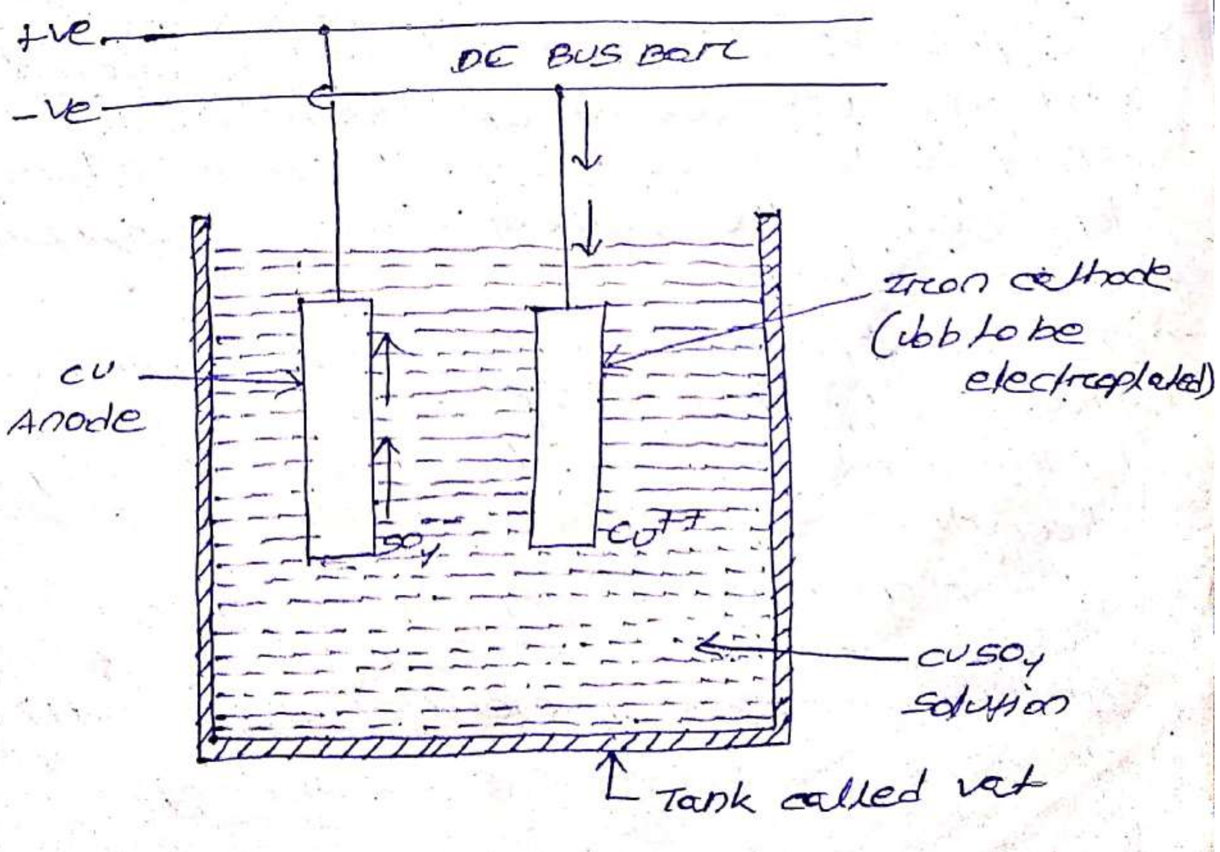
NEED OF ELECTROPLATING

→ To protect the metal against corrosion.

→ To give signing appearance to a metal

→ To repaire a damage casting etc.

PRINCIPLE:



→ Here two electreodes are taken and are deeped in an electrolyte and DC supply is applied to the electreodes, so the electreolyte will get desolved into ions called anions and cataions.

→ consider the case of iron ring to be plated with copper. In this case the electreolyte is taken as copper sulphate ($CuSO_4$). which will get desolve into Cu^{++} and SO_4^{--}

→ The Iron ring which is to be plated is taken as cathode and the cu metal is placed at the anode.

→ The desolved SO_4^{--} ions will move towords the anode which have a surpluse of two number of electreons. Each SO_4 ion will donet the two no. of extra electreone to anode and become SO_4 redicals.

→ This SO_4 redicals will attract the cu anode to form $CuSO_4$ molecules which again desolves in water to maintain the electreolyte concerntreation.

→ The positive Cu^{++} ion will moves towored cathode and receives two no. of electreons from the supply to form cu atom. these cu atom get deposited at the cathode. The cu deposited at the cathode.

→ The cu deposited at the cathode surfece is preactically having the same mass as lossed by the anode. In maintaing the electreolytle strength.

→ This phenomenon of deposition of a metalic coating on the surfece of other metal through the process of electreolysis is called electreodeposition or electreoplating.

17.12.19

TERMS REGARDING ELECTROLYSIS

1. ELECTROLYTE

The solution of salt when used in the process of electrolysis is called an electrolyte.

2. ELECTRODES

The rods we must in an electrolyte and connected to DC supply is called electrodes.

3. ANODE

The +ve electrode are anode.

4. CATHODE

-ve electrode are cathode.

5. ANIONS/CATAIONS

When DC current is passed through an electrolyte it can desolve into +ve ions and -ve ions. This positively charged ions are called cataions and negatively charged ions are called anions.

6. ATOMIC WEIGHT

→ It is the ratio of weight of an atom of the element to the weight of an atom Hydrogen.

(or)

→ It is also defind as weight of all the isotops present in that atom.

7. VALENCY

→ It is the no. of hydrogen atom with which the atom will react chemically.

8. CHEMICAL EQUIVALENT WEIGHT (C.E.W)

It is defind as the ratio of atomic weight to valency of the substance.

9. ELECTRO CHEMICAL EQUIVALENT (E.C.E)

It is the amount of substance deposited at the cathode on passing a stedy electric current of 1A for 1sec through it solution.

FARADAY'S LAW OF ELECTROLYSIS

1ST LAW

It's state that the weight of substance liberated from an electrolyte in a given time is directly propositional to the quantity of electricity passed in that time.

Mathmetically,

$$W \propto Q$$

$$\Rightarrow W \propto It$$

$$\Rightarrow \boxed{W = Z \cdot It}$$

where,

Z = Electro chemical equivalent.

2ND LAW

If the same current flows for a given time to several electrolytes then the weight of substance liberated are propositional to there chemical equivalent weight.

$$\frac{\text{weight of Cu deposited by same quantity of electricity}}{\text{weight of Ni deposited by same quanity of electricity}} = \frac{\text{C.E.W of Cu}}{\text{C.E.W. of Ni}}$$

20.12.19

CURRENT EFFICIENCY

Due to presents of certain impurity which causes secondary reaction the quantity of substance liberated is less than calculated from Faraday's law i.e called current efficiency.

$$C.E = \frac{\text{Actual quantity of substance liberated}}{\text{quantity of substance to be liberated as per Faraday's law or theoritically}}$$

→ so the value of the current efficiency lies in between 90-98%.

ENERGY EFFICIENCY

$$E{:}E = \frac{\text{Theoretically energy}}{\text{Actual energy produced}}$$

→ Due to secondary reactions the actual voltage required for deposition or libration of metal is higher than the theoretical value which will increase the actual energy require.

→ Energy efficiency is defined is the ratio of theoretically energy required to the actual energy produce.

FACTORS AFFECTING ELECTRODEPOSITION OR ELECTRO-PLATING

1. TIME
Time is directly propositional to the quantity of electro deposition so more weight of substance will be deposited is more time and less mass will be deposited in less time.

2. EFFICIENCY
→ Greater is the efficiency greater is the quantity of metal deposited for a given time.

3. CURRENT
→ value of current is also directly propositional to the mass of metal deposition.

4. STRENGTH OF ELECTROLYTE
If the strength of solution will be more than the mass of metal deposited will be more as compaire to dilute solution electrolyte.

FACTORS AFFECTING BETTER ELECTRO DEPOSITION

1. CURRENT DENSITY
At low current density the ions are released at slow rate therefore the deposit will be ~~more as compaire to~~ crystaline in nature. But at higher current density the quantity of deposit become more uniform and fine. so at higher current density electrodeposition will be better.

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→ But if the current density exceed the limitting value for electrolyte then spongy and ~~pro~~ porous deposite will be obtain.

2. EELECTROLYTE CONCERNTRATION

By increasing the concerntreation of electrolyte higher current density can be obtain and electrolyte tends to be better deposit.

3. TEMPERATURE

Temperature of electrolyte is different for different metal to have better deposit for example cromium plating temp 35°C

Cu 50°C

Ni 50°-60°C

(4) ADDITIONALS AGENTS

The quality of deposition improved by the presents of an additional avents which may be an organic compound such as gum, rubber, suggar etc.

(5) NATURE OF ELECTROLYTE

→ The smoothness of deposite largly depends on the nature of electrolyte i.e example silicon from silicon dioxide $AgNO_3$ solution from rough deposit which that from a cyanide solution form a smooth deposite.

24.12.19 THROWING POWER

The throwing power of an electrolyte may be regardless the quantity which produces a uniform deposit on a irregular cathode surface.

→ since the surface is irregular so the resistance to current path from ~~cade~~ anode to the far end will be more as compaire to the near end. so the amount of deposit on the far end will be less as compaire to the near end.

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→ The throwing power can be improved in two ways

i. By increasing the distance between the anode and the object such that the relative variation resistance between anode and different part of object is reduced.

ii. By ~~increasing~~ using some colloidal metal which results in increase in the current density

Ex-Addition of cyanides.

EXTRACTION OF METAL

This can be done two in way

1. when the ore is in the molten state it is directly electrolyte in the furnace.
2. The ore is treated with the strong acid to obtain a salt and the salt is electrolysied to extract the metal.

1. EXTRACTION OF ZINC(Zn)

→ The ore consisting of zinc which primary component is ZnO_2 (zinc oxide) is treated with concentreated ~~sa~~ sulfuric acid (H_2SO_4) and passed through various chemical process to remove impurities like cadmium(Cd), Cu etc.

→ The zinc sulfate solution which is ~~are~~ obtain now electrolyte. this electrolytic process is carried out in wooden box with inner lining of lead the anodes are lining of lead and the cathodes are of aluminium. zinc will be deposited at ~~t~~ cathode.

2. EXTRACTION OF ALUMINIUM(AL)

→ ores of Al are Buxide, cryolite, and Bauxite. Buxide is treated chemically and reduce to 'Al' oxide and then it is desolved with cryolite and now electrolysed.

→ The furnace is lies with carbon at a temp. is about 1000°C and Al is deposited at cathode.

3. REFINING OF METAL

→ Electrolyting extraction gives about 98 to 99% of pure metal furthere refereing is done by electrolysis.

→ The anodes are made up impure metal extracted from its ore and electrolyte is a solution of salt of the metal pure metal will get deposited on the cathode.

APPLICATIONS OF ELECTROLYSIS

1. Extraction of metal from theire ore
2. Extraction of Al
3. Extraction of Zn
4. Refining of metals
5. Electrodeposition
6. production of chemical
7. separating metal from their compound.
8. Electro typing
9. Electro forming
10. Electrocleaning.

6. PRODUCTION OF CHEMICAL

Many chemical such as caustic soda (KOH) ~~Cl₂~~ chloride gas, Amonium ~~phosphate~~ phosphate etc. are producinged by electrolysis in large scale.

7. SEPARATING METAL FROM THEIR COMPOUND

many metals are separated from theire compound by electrolysis

8. ELECTRO TYPING

→ First the is prepared of the type in works and then it is coated in black lead to give metalic surface and there it is subjected to electrolytic process where laire of copper is form.

9. ~~EE~~ ELECTRO FORMING

→ The production or reproduction of an article by electrodeposition is called electro forming.

10. ~~E~~ ELECTRO CLEANING

A solution of sodium phosphate is used as an electrolyte in the plating tank. Tank is connected to the +ve terminal of DC supply and work piece is made cathode which is suspended in the solution heavy current is passed through the solution and caustic soda is produced at the cathode which have a cleaning action.

→ Also during the process hydrogen gas is envolved at the cathode which removes materials like grees this process is called electro cleaning.

07.02.20

CHAPTER-2
ELECTRICAL HEATING

ELECTRIC HEATING

when an electric current flows through a substance heat is produced and this is the principle of electric heating.

→ when current I flows through a ckt having resistance of R OHM the power dissipated in the ckt is given by I^2R watt. If the current flows for t sec then energy consumed = I^2Rt Joule or watt sec

→ This energy consumed is converted into heat and found as

$$H = \frac{I^2Rt}{4.2} \text{ calories}$$

→ Mechanical equivalent of heat = 4.2

→ There are 3 modes of heat transfer
1. conduction
2. convection
3. Radiation.

→ solid object are generally heated by conduction.

→ liquid are heated by convection

→ Distance object are heated by radiation.

→ Electric heating finds application both in domestic as well as industrial applications

DOMESTIC APPLICATION

→ Electric ~~heating~~ heaters

→ Room heaters

→ Electric Irons

→ Gysers

→ Emotions Rod

→ popcorn plant

→ Electric oven

→ Toaster

INDUSTRIAL APPLICATION

- → Melting of metal
- → Heat treatment of metal like annealing, soldering.
- → Moulding of glass
- → For making glass appliances
- → Making of plywoods.

03.02.20

ADVANTAGES OF ELECTRIC HEATING OVER CONVENTIONAL METHOD OF HEATING

1. CLEAN AND NEAT ATMOSPHERE

No coal dust or smoke and operator hand don't glow black while operating appliances in electric heating.

2. NO POLUTION

There is absence of fuel gases so this method is polution free.

3. CONTROLLED TEMP.

Temp. can be control within the ±5°C which is not possible in conventional method of heating.

4. EASE OF CONTROL

→ Heating can be started instantaneously or stopped at a required time.

5. LOCALISED APPLICATION

A work piece can be heated up to a particular depth for heat treatment where as work piece as a whole receives it in non-electric heating.

6. LOW AMBIENT TEMP

The temp around an electrical furnace is much lower as compaire to that around non-electrical furnace.

7. UNIFORM HEATING

Heating can be generated with in the work piece resulting in uniform heating of the work piece

8. HEATING OF BAD CONDUCTORS OF HEAT AND ELECTRICALLY

→ wood, plastic and bakerey items can be uniformly heated by dielectric heating process.

9. HIGHEST EFFICIENCY OF UTILISATION

Heat produced electrically do not go weast through chimeny and other by products resulting in high efficiency.

10. CHEAP FURNACE

Electrical furnce do not reequired big space for installation no storage of coal or wood is necessary no chimeny is required so the electrical furnace become cheap as compair non-electrical furnace.

11. MOBILITY OF JOB

pieces under will heat treatment can be mounted on a conveir passing through heating cabinate at making use of electric heaters.

DIFFERENT MODES/METHODS OF HEATING

→ There are 3 mode of heat transfer
1. conduction
2. convection
3. Radiation.

1. CONDUCTION

→ In this ~~method~~ mode of heat transfer one molecule of the body gets heated and transfers some of the heat to adjecents molecule and so on.

→ There is a temperature gradiant between the two ends of the body being heated.

2. CONVECTION

→ In this process heat is transferred by the ~~two ends~~ flow of hot and cold air content. This process is applied if the heating of water by Emotions rod.

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3. RADIATION

→ It is a method of transfer of heat from a hot body to a cold body in a strait line without affecting the intevening midium.

→ **STEFAN'S LAW**

Rate of heat emission

$$H = 5.72\, ek \left[\left(\frac{T_1}{100}\right)^4 - \left(\frac{T_2}{100}\right)^4 \right]$$

e = emissivity of heating element

k = Rediating effect.

METHODS OF HEATING

Electric Heating

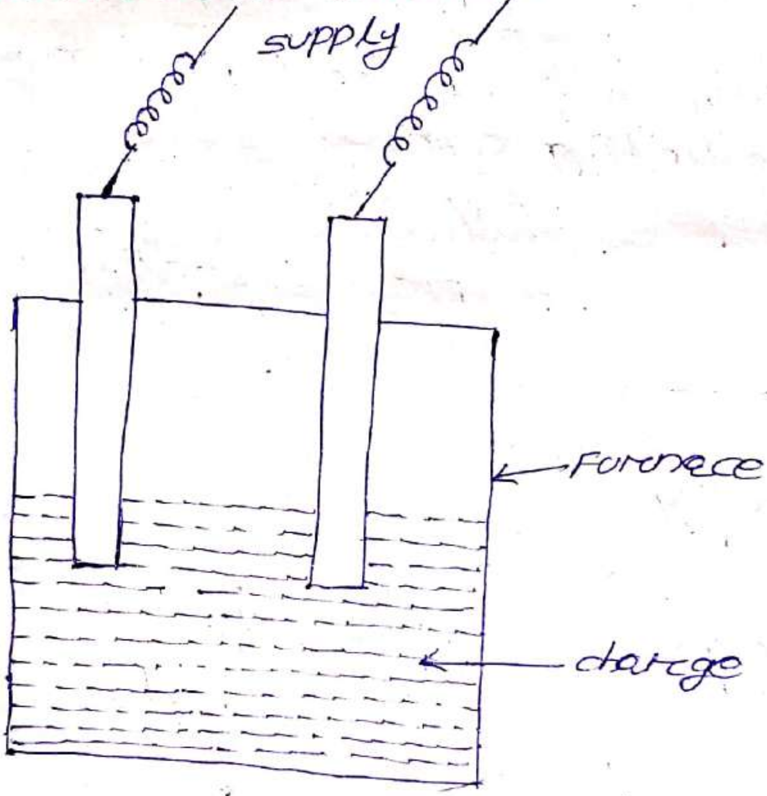
- power frequency heating
  - Resistance Heating
    - Direct resistance heating
    - Indirect resistance heating
  - Arc Heating
    - Direct Arc heating
      - conducting bottom type
      - Non conducting buttom type
    - Indirect Arc Heating
- High frequency Heating
  - Induction Heating
    - Direct core type.
    - coreless type
  - Dielectric Heating

RESISTANCE HEATING

In resistance heating current flows through a resistance element due to the I^2R loss heating is produced

→ Resistance heating is clasified into two types
1. Direct resistance heating
2. Indirect resistance heating.

1. DIRECT RESISTANCE HEATING



→ In this method of heating the materials or charge to be heated is taken as resistance and electric current is directly pass through it.

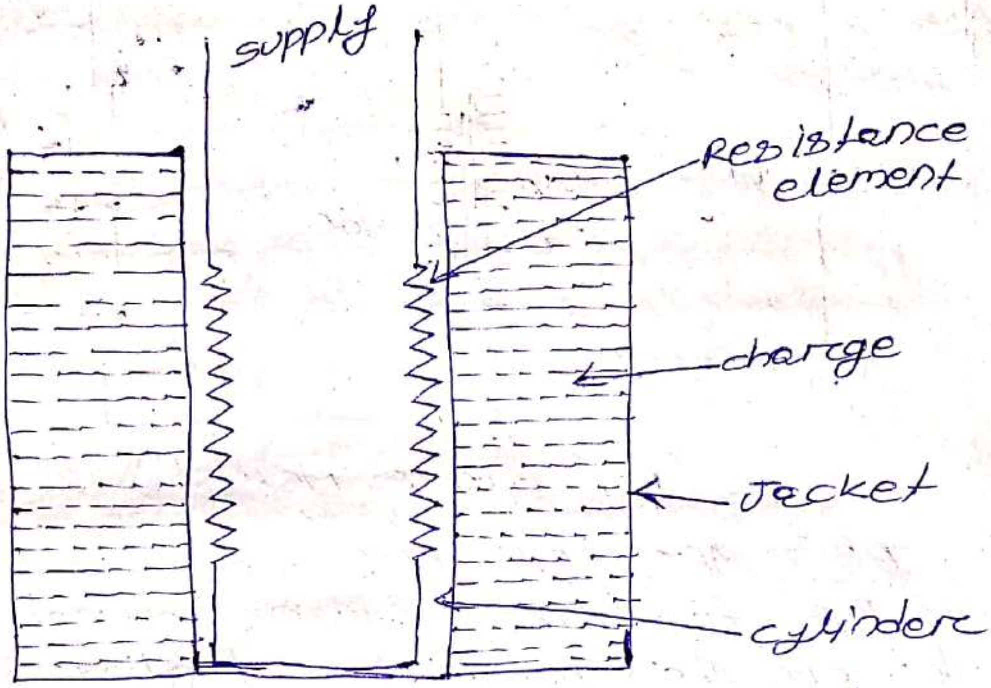
→ Two electrodes are placed inside the charged and they are connected to supply.

→ When metal piece is to be heated a powder of high resistive material springed over the surface of the charge to avoid short ckt.

→ This method is high efficiency since heat is produced inside the charge itself.

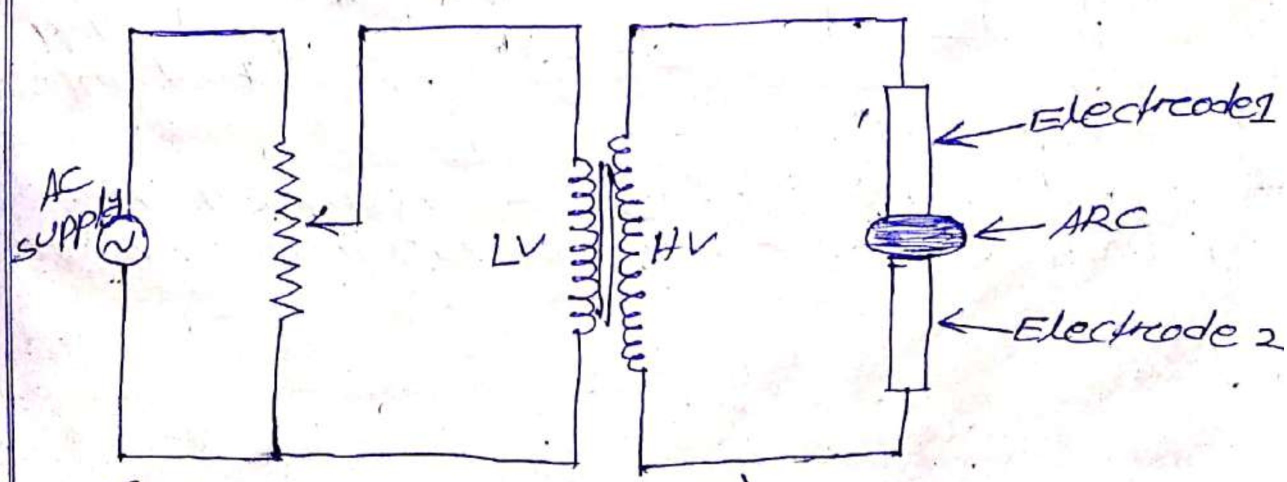
→ Measure application of this process is ~~s~~ salt bare furnace having operating temp between 500 °C to 1400 °C.

2. INDIRECT RESISTANCE HEATING

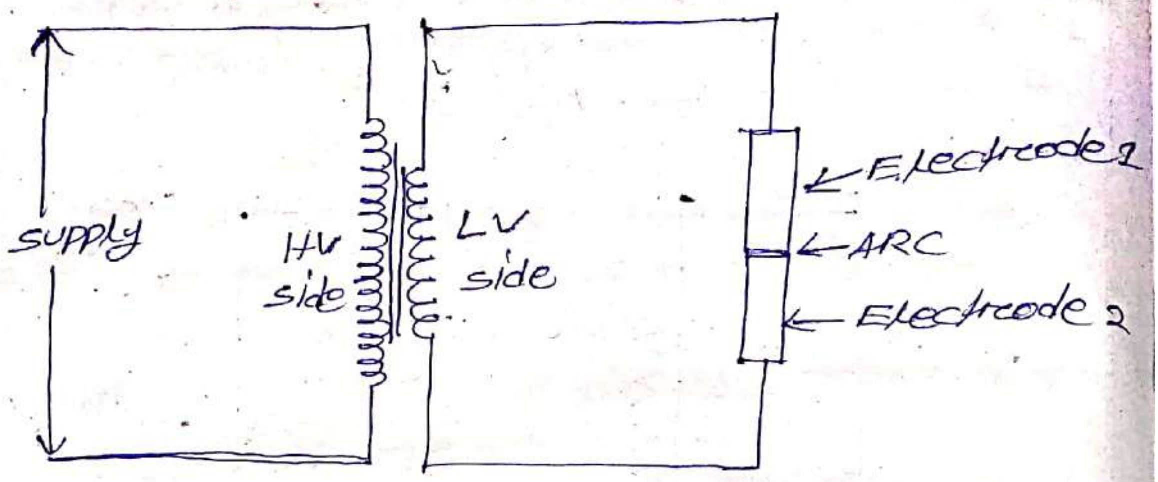


- In this method current is passed through a highly resistance element which is placed either above or below the oven depending on the nature of job to be performed.
- The heat propositional to I^2R loss is produced in the heating element which is delivered to the charge either by convection or by radiation.
- In case of industrial heating the resistance is placed inside a cylinder which is surround by charge placed inside a jacket common example is resistance oven.

ARC HEATING



(HT STRIKE METHOD)



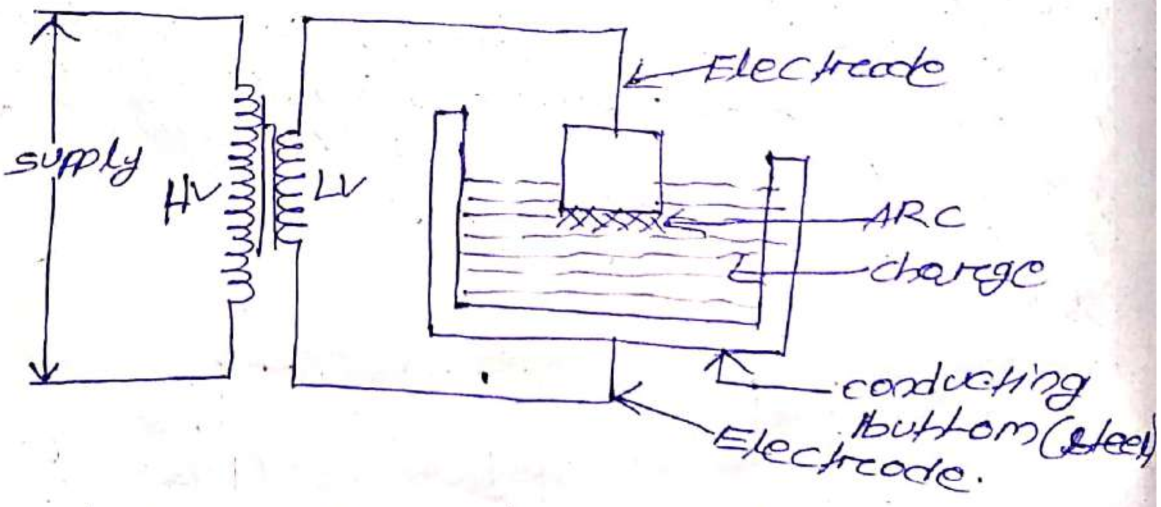
(LT strike method)

1. DIRECT ARC HEATING

→ In this case arc is struck between the electrodes and the charge to be heating such that the arc current flows through the charge and there is a direct contect between the arc and the charge.

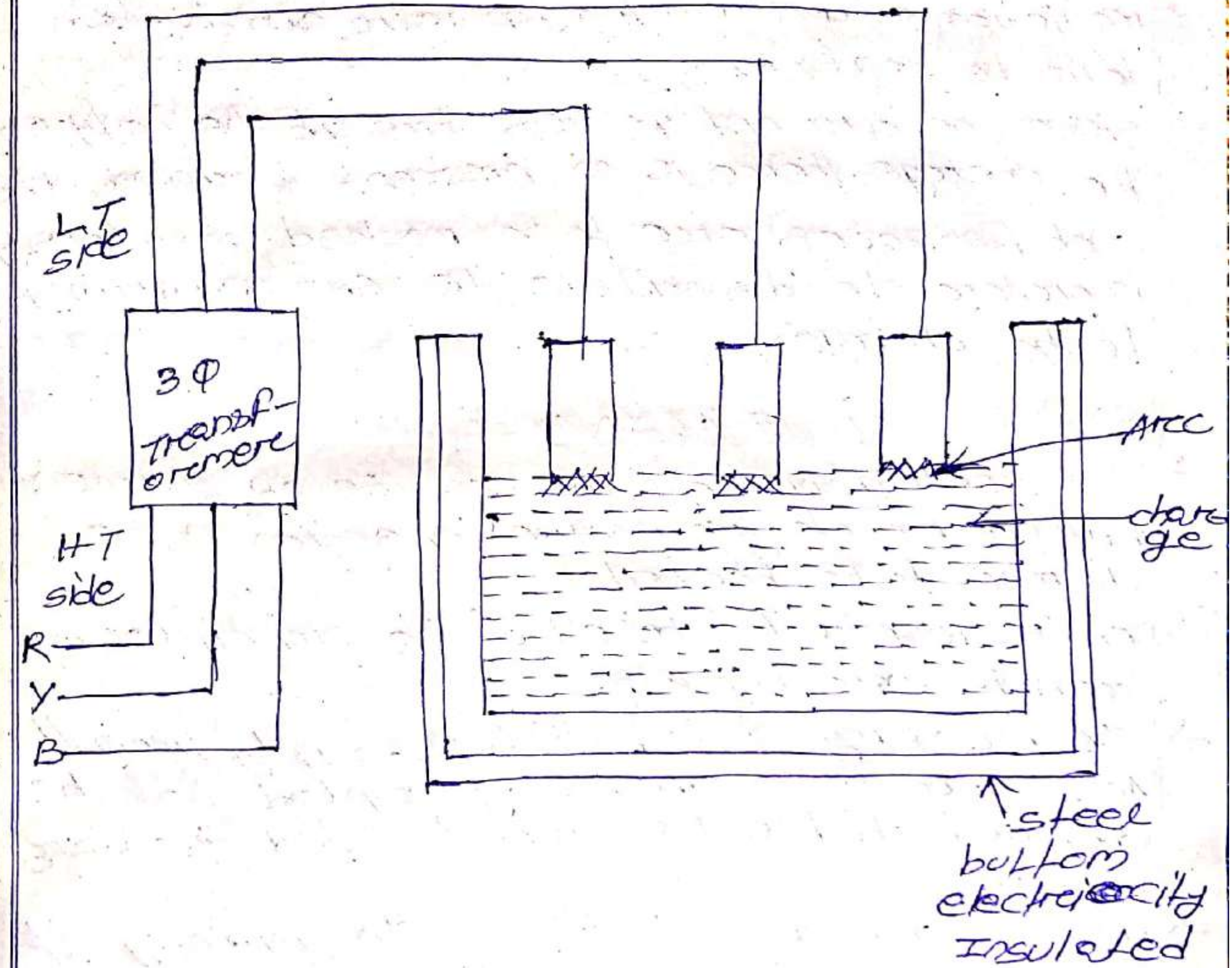
→ Heating is faster and heating efficiency is high.

i. CONDUCTING BUTTOM TYPE



→ In conducting Buttom type the buttom of the furnace act at a part of electric ckt

ii) NON-CONDUCTING BUTTOM TYPE



→ In non conducting buttom type furnace no current flows through the buttom of the furnace.

→ most of the furnace used arce non-conducting buttom type because of no insulation problem.

INDIRECT ARC FURNACE (Next page)

→ In this case heat is produced by the arcc between two electrodes which does the heating two electrodes which does not heating indirectly.

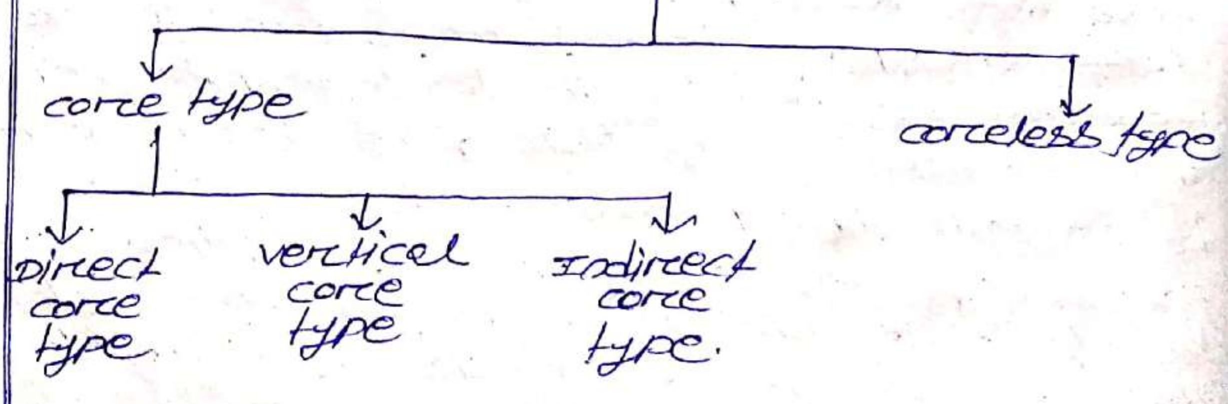
→ Arcc does not come indirect contect with the ~~charge~~ charge but heat is transfered through rediation from arcc to the top lair of the charge and then from the top lair of the charge to the buttom lair through conduction.

→ In this case low voltage 1φ AC is applied across the electrodes arcc is struck by short ckt io the electrodes for a moment ~~ckt in the electro~~ and then separating it.

- → Heat from the arc is transferred to the top lair of the charge and refractory Lining through radiation and from the top lair and buttom lair to conduction.
- → since no current passes through the body of the charge there is no inherent stirring here such furnaces are to be rocked continiously in order to distribute the heat uniformly to the charge.

INDUCTION HEATING

- → This heating process makes use of current induced by electro magnetic action in the charge to be heated.
- → It is generally based on the principle of transformer working.
- → The primary winding which is supply from the AC source is magnetically coupled to the charged which act as short ckted secondary winding.
- → when AC voltage is applied to the primary it induces voltage in the secondary winding i.e the charge the emf in the secondary side is produce & a current which heats up the charge.
- → The value of this current depends on magnitude of primary current turnratio of the T/F, co-efficient of magnetic coupling etc.
- → Low frequency induction furneces are used for heating and melting of metal.



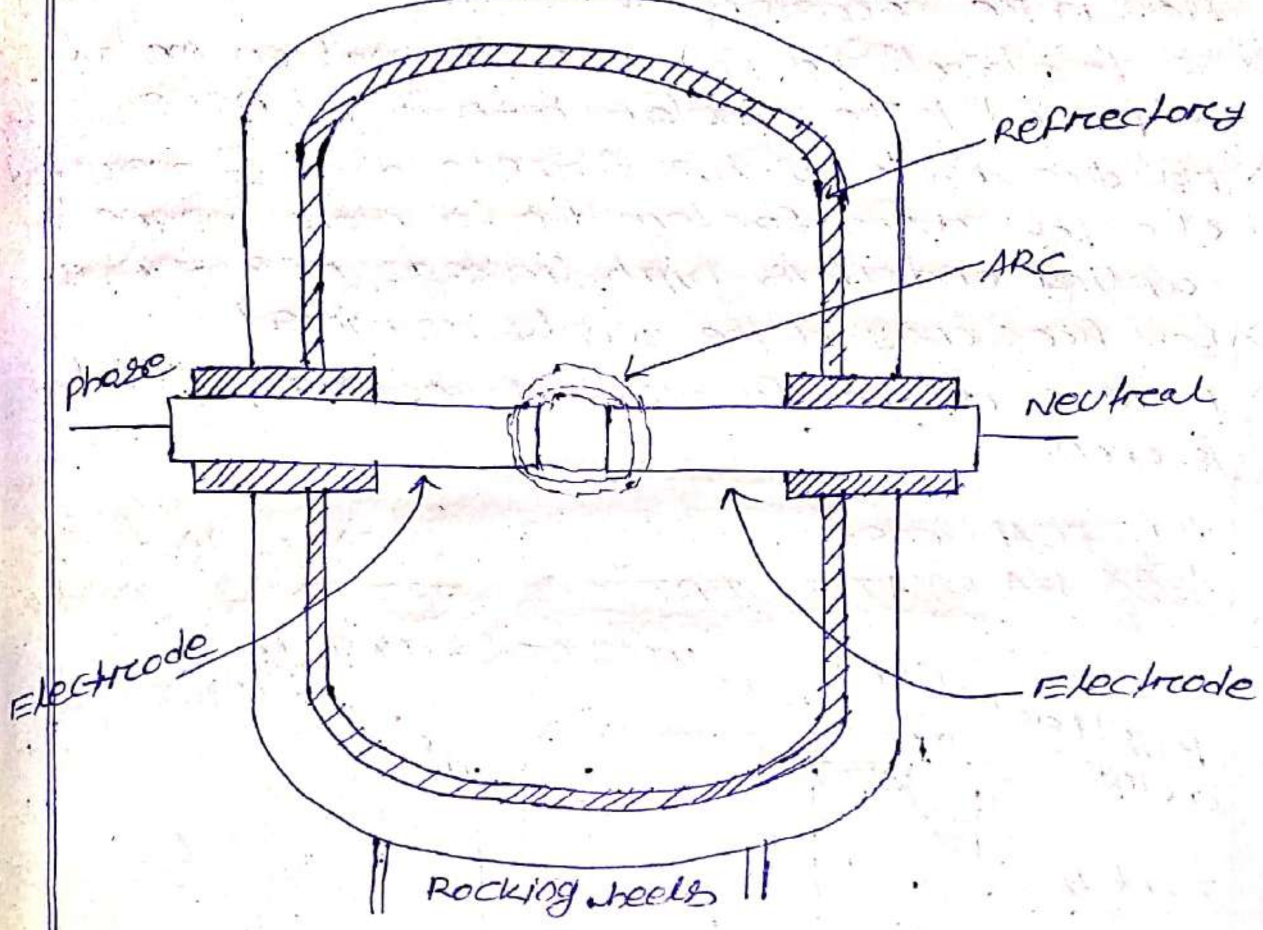
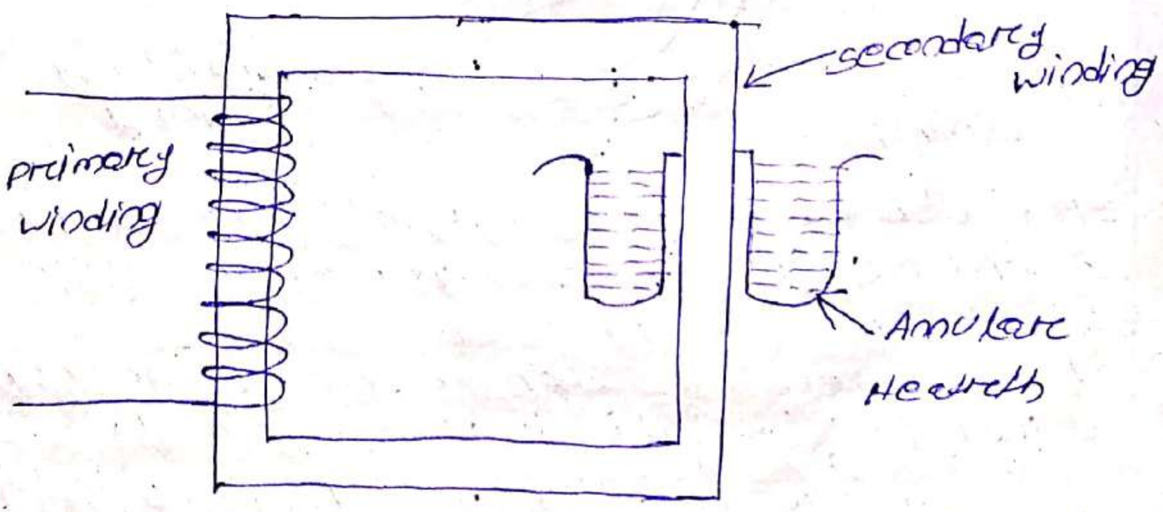


Fig: Indirect Arc Furnece

DIRECT CORE TYPE INDUCTION FURNACE



- It is like T/F having the charge forms the secondary winding and consist of one term only formed by the metal to be melted.
- The charged is magnetically coupled to the primary winding.
- Electro magnetic force are set up by the high current in the melting metal.

→ When there is no molten metal, no current will flow in the secondary winding.

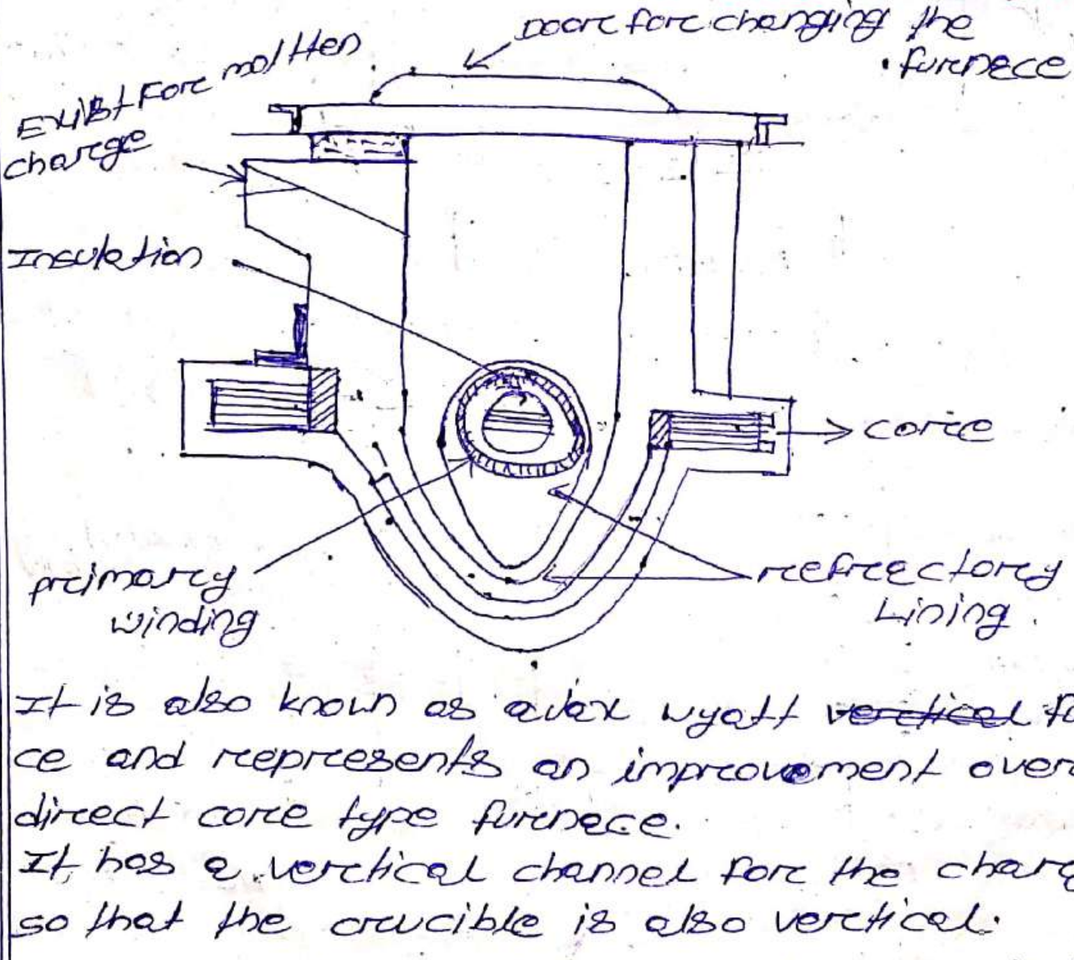
→ so to start the furnece the molten metal is poured in the annular ~~hearth~~ furnece.

→ Few drawback of this furnece are it operated at a low power factor due to poor magnetic coupling and it is high lickage reactance.

→ Low frequency of the supply required

→ Furnace can not function if secondary ckt is open.

VERTICAL CORE-TYPE INDUCTION FURNACE/ AJAX ~~WA~~ WYATT VERTICAL CORE TYPE FURNACE



→ It is also known as ajax wyatt ~~vertical~~ furnece and represents an improvement over the direct core type furnece.

→ It has a vertical channel for the charge so that the crucible is also vertical.

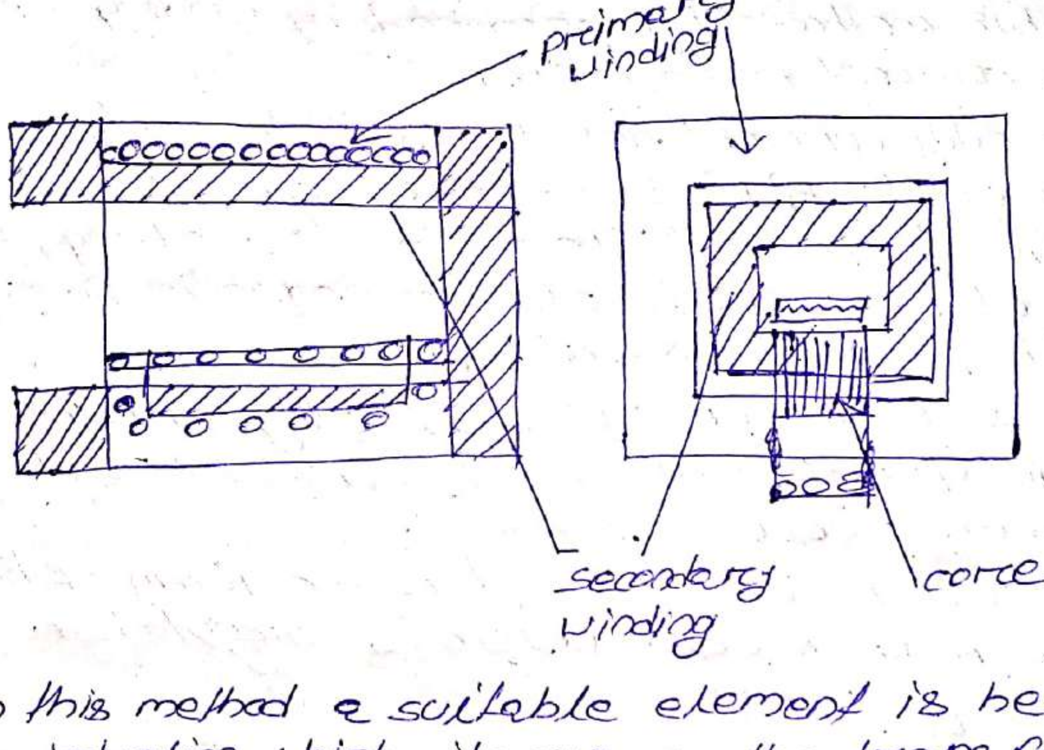
→ The magnetic coupling in the furnece is better than direct core type so lickage current is compairatively low and power factor is high so it can operate from normal frequency supply. i.e 50Hz

> The circulation of molten metal is kept up round the 'V' position by convection current and in the lower half of 'V' section by electro magnetic forces between the induced current.

> It is necessary to kept the 'V' section full of metal, inorder to maintain the continuity of secondary ckt so that the ckt is suitable for continious operation.

> The top is covered with insulated cover which can be remove for charging. Hydraulic tilting arrangement is there to take molten metal.

INDIRECT CORE TYPE INDUCTION FURNACE



> In this method a suitable element is heated by induction which its ~~on~~ on the transfer the heat to the charge by radiation.

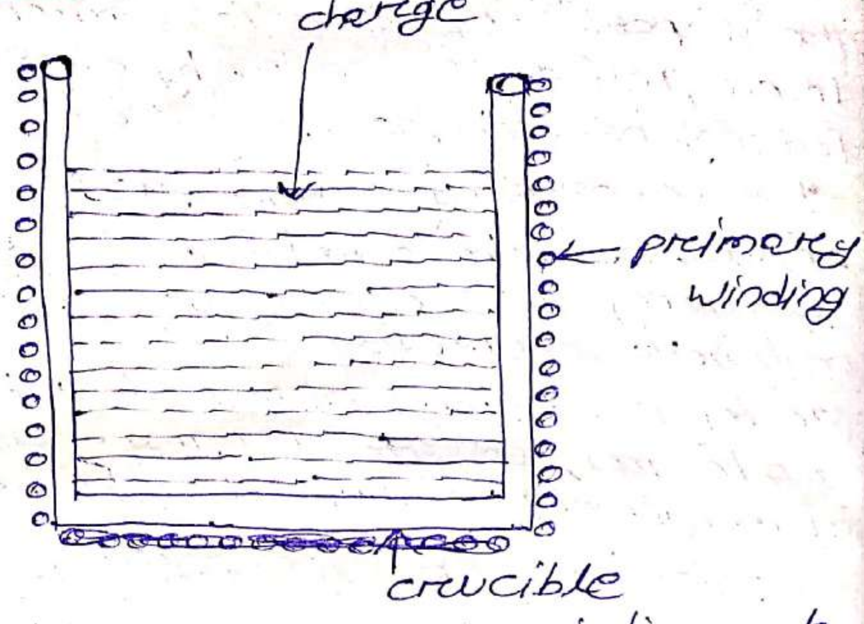
> The secondary winding consist of metal cointainer which forms the wall of the furnace.

> The primary winding is magneticaly coupled to the secondary winding by an IRON core.

> When primary winding connected to AC supply secondary current is used in the metal cointainer by the T/F action.

> The metal container transfers the heat to the charge. this method is advantages because its temp. can be automaticaly controlled without the use of external equipment.

CORELESS TYPE



- In this method flux produced by winding sets up eddy current in the charge.
- The eddy current developed is directly propositional to $B_m^2 f^2$ these eddy current are sufficient to heat the metal to melting point and also ~~st~~ set up electromagnetic forces which produces a strickly action.
- The direction of resultant eddy current will be in oposite direction to current will primary coil.
- The coil is constructed is the form of hollow through which cold water is circulated.

SKIN EFFECT

when DC supplied across the conduction is distribute uniformly over the whole cross-section of the conductor but in the case of AC the distribution of the current will not uniform the AC current tends concentrated near the surface of the conductor and almost no current flow through the core of the conductor this phenomenon of concentration of AC near the surface area is called skin effect. and it increases the resistance of the conductor.

→ At low frequency the skin effect is small but its effect become significantly at high frequency.

14.02.20

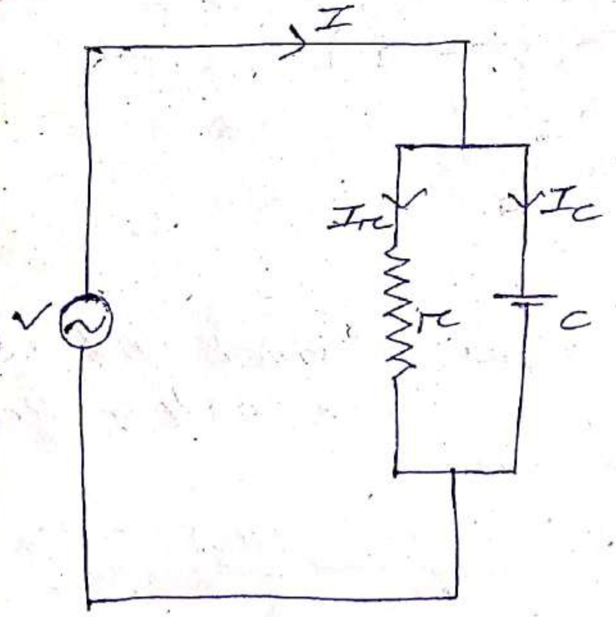
→ ~~This~~

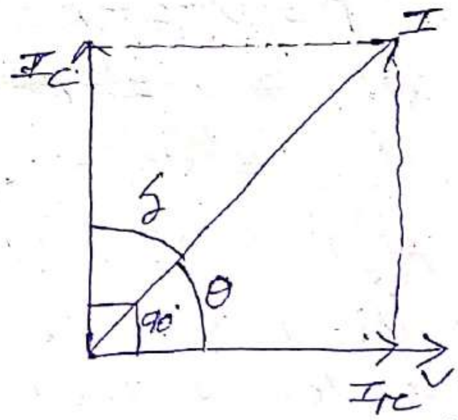
DIELECTRIC HEATING

→ This also called high frequency capacity heating and is employed from heating insulating materials like wood, ceramics, plastic etc.

→ The supply voltage applied in this type of heating is in the range of 20kV and the frequency is about 20 to 30 mega(M) Hz

PRINCIPLE





δ = Dielectric loss angle.

$I_{rc} << I_c$

$\Rightarrow I = I_{rc} + I_c \cong I_c$

$\sin\delta = \frac{I_{rc}}{I}$

$\tan\delta = \frac{I_{rc}}{I_c}$

→ when a dielectric material subjected to sinusoidal voltage the current run by it will never ~~lead~~ lead the voltage by an angle 90° rather the angle between voltage and current will be less than 90° ~~rather~~ by an angle δ called dielectric loss angle.

→ There is certain component of current which is always inphase in the voltage and produced a powerloss called dielectric loss.

→ At high freequency the loss will be verey high and reflected as heat which will heat the material.

$$power(P) = VI\cos\theta$$

$$I \cong I_C$$

$$\Rightarrow P = VI_C \cos\theta$$

$$= V \cdot \frac{V}{X_C} \cos\theta$$

$$= V \cdot \frac{V}{\left(\frac{1}{2\pi FC}\right)} \cos\theta$$

$$= V^2 2\pi FC \cos\theta$$

$$P = V^2 2\pi FC \cos(90 - \delta)$$

$$\Rightarrow P = V^2 2\pi FC \sin\delta$$

$$\Rightarrow P = V^2 2\pi FC \tan\delta$$

$$\Rightarrow P = V^2 2\pi FC \delta$$

→ So this is the amount of power which will be converted to heat and used for heating the material.

APPLICATION OF DIELECTRIC HEATING

→ plywood Industrey
→ plastic Industrey
→ Tombacco Industrey
→ Bakeries
→ Electreonic sewing
→ Dehydration of Food.

MICROWAVE HEATING

→ In this method electricity is converted into electromagnetic waves which generates heat energy.
→ The wave length of this wave is very less and having high freqeuency and thats way

hence known as microwaves.

-> when this microwave comes in contact with certain substance it is reflected transmitted or absorbed.

-> when this wave get absorbed heating effect will occure.

-> Microwave heating is used in microwave ovens for baking purpose the frequency is used is in the range of 900MHz to 2400MHz

APPLICATIONS

-> Baking of bread/Toast.

-> Drying of paper and textiles

-> Food processing

-> Treatment of cancer

-> processing of cement and timber etc.

CHAPTER-3

ELECTRIC WELDING

GENERAL WELDING

It may be defind as the process in which metals are Joint by heating them to a suitable temp with or without the application of pressure and addition of filter metals.

ELECTRIC WELDING

→ It is defind as the branch of welding in which electric current is passed to produce large amount of heat for Joining together two pieces of metal to form a union.

→ In electric welding heat is produced either by striking an arc between the electrode and the metalic Joint or by passing a heavy current through the Joint.

→ The first method is called electric arc welding where as the second method is called resistance welding.

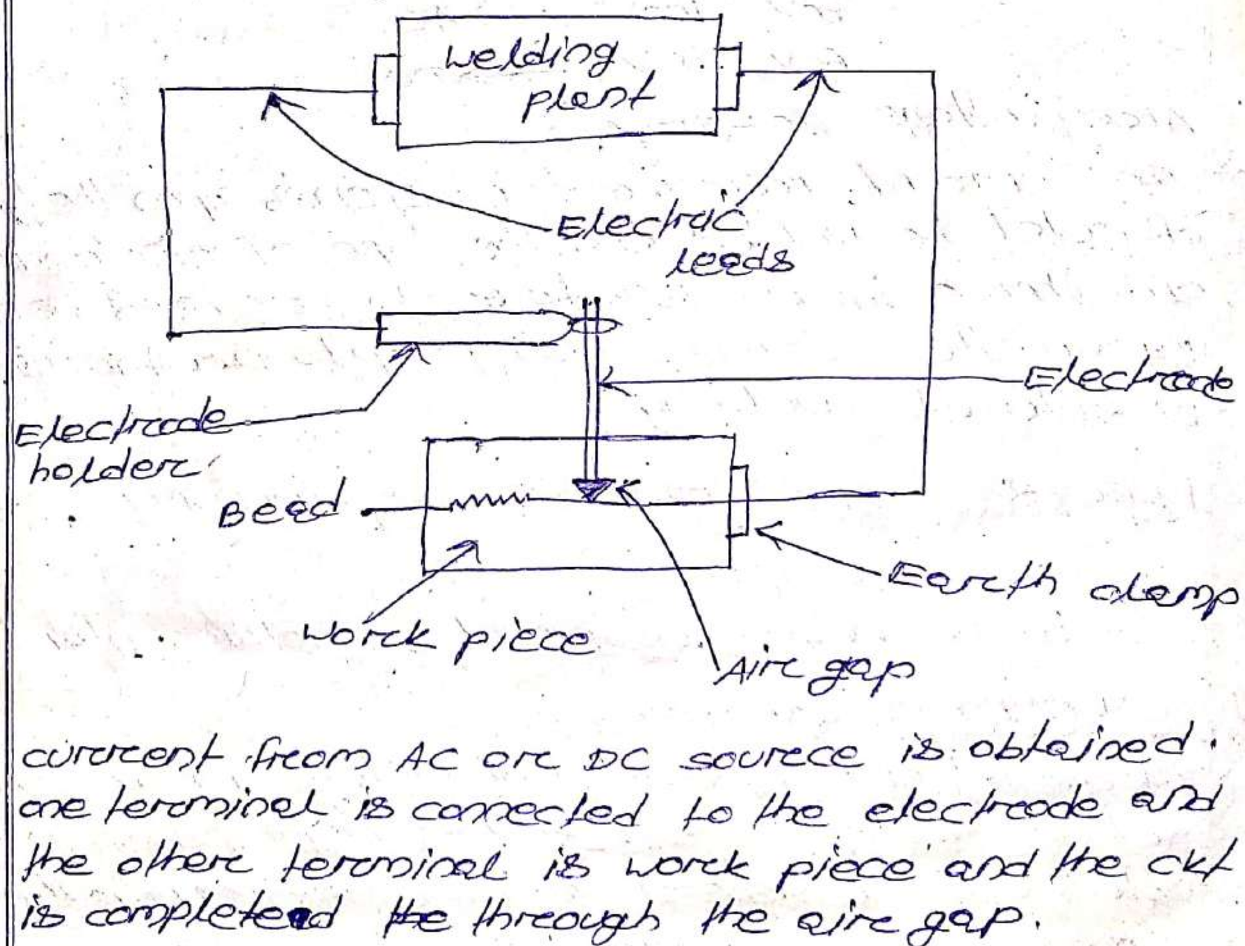
Electric welding

- Electric arc welding
  - Metalic arc welding
  - carbon arc welding
  - Atom Hydrogen welding
  - Helium or Argon welding
- Resistance welding
  - Butt welding
  - Flash welding
  - spot welding
  - seam welding
  - Projection welding

ARC WELDING

An electric arc is produced by bringing two conductors connected to a suitable source of electric current momenterily in contect and then separating them by a small distance.

> The current will flow across the small gap continiously and produced high heat.
> That heat developed is utilised to melt the part of the work pieces and the filler metal to form a joint.
> so the welded joint is a union of metal parts made of localised heat without any pressure.
> For arc welding the temp is about 3000°C. maximum voltage for welding is about 100 V and current range from 32 to 600A.



> current from AC or DC source is obtained. one terminal is connected to the electrode and the other terminal is work piece and the ckt is completed the through the air gap.
> The gap is provided between the tip of the electrode and the surface of work piece by keeping the electrode at the distance is about 3mm to 6mm from the work piece.
> Due to the air gap arc will be produced which will result in heating effect and the temp. ranges from 3700°C to 4000°C

→ This high temp. will melt the metal and welding take place.

CONDITION FOR SUCCESSFUL WELDING

→ The main requirements are a relatively high striking voltage to enable the arc to be strucked and maintain stability.

→ A relatively low voltage is required to enable the arc to be maintain without being violent and the current of the correct value to melt the metal and the electrode without burning.

sprking voltage

80V – 100V ⟶ AC
60V – 80V ⟶ DC

Arc voltage 20–35V

→ The current required is depends upon the type of metal be welded and the type of electrode and where is now 15A to 600A; For hand welding and the current can go up to 1200A incase of automatic welding.

ELECTRIC ARC WELDING EQUIPMENT

1. DC welding equipment
2. DC welding.equipment/AC welding plant.

1. DC WELDING EQUIPMENT

→ It consist of a generally a motor generator set. The motor is a squirrel cage induction motor and the generator is a differentially compound DC Generator to give drooping char.

→ In such generators the terminal voltage falls automatically with increasing in load current.

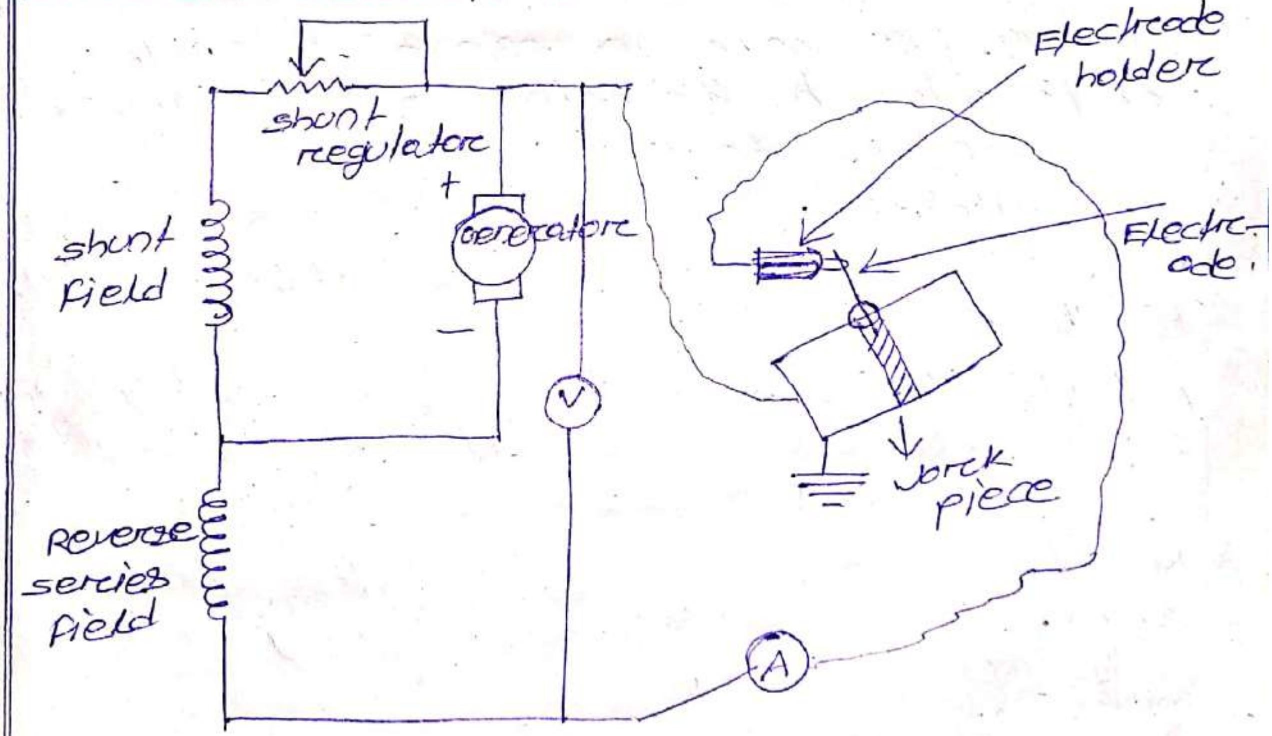
2. AC WELDING PLANT

In this case a T/F is used to reduce the voltage to about 100V to regulate the current and produce a drooping char. a resistance or reactance may be used.

WELDING ACCESSORIES

1. AC or DC welding plant
2. one electrode holder fitted with a length of flexible cable.
3. Another flexible cable which is connected to the work piece.
4. one face screen fitted with coloured glasses.
5. observer face screen fitted with coloured glasses
6. pair of lather globs.
7. one chipping hammer to remove slag.
8. one brush to clean the weld after chipping.

STANDARD METHODS FOR DC GENERATOR

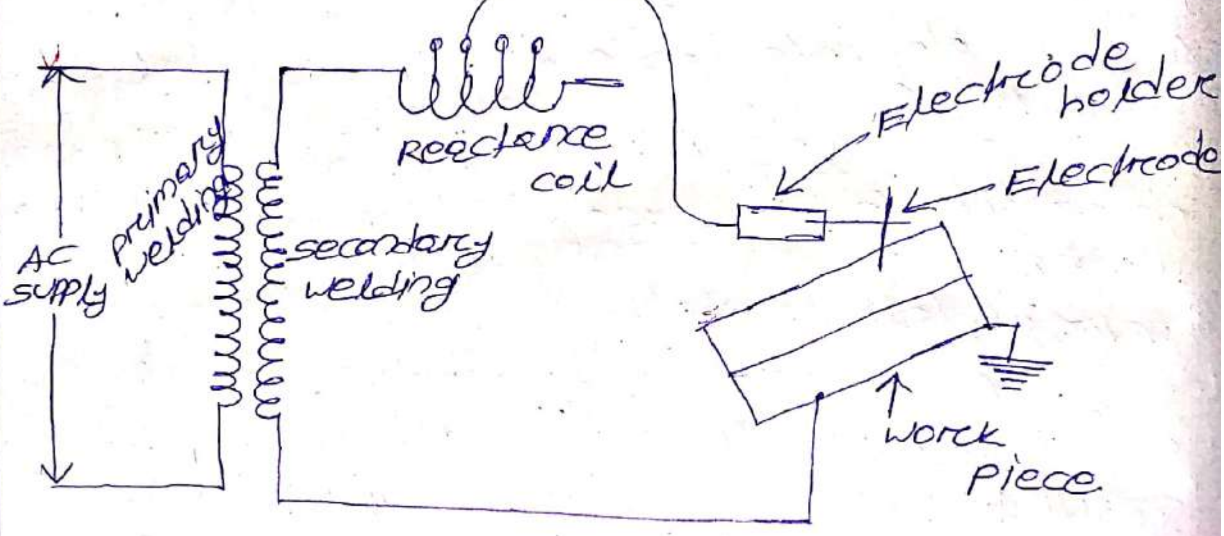


→ In this method the series field are connected in the reverse direction to the shunt coil. and therefore the field created by the series field will be in opposition to field created by the shunt ~~coil~~ coil.

→ on open ckt shunt field is only operating and maximum voltage is available to struck the arc.

→ When the arc is struck current will flow through series winding producing or creating opposition shunt field. so resultant field strength decreases and voltage drops. and drooping char. can be achived.

USE OF REACTANCE COIL FOR AC EQUIPMENT



→ The drooping char. in case of AC equipment can be obtain by the help of a reactance coil in series with the arc.

→ The voltage at the secondary side of the T/F remains constant and is available for striking the arc.

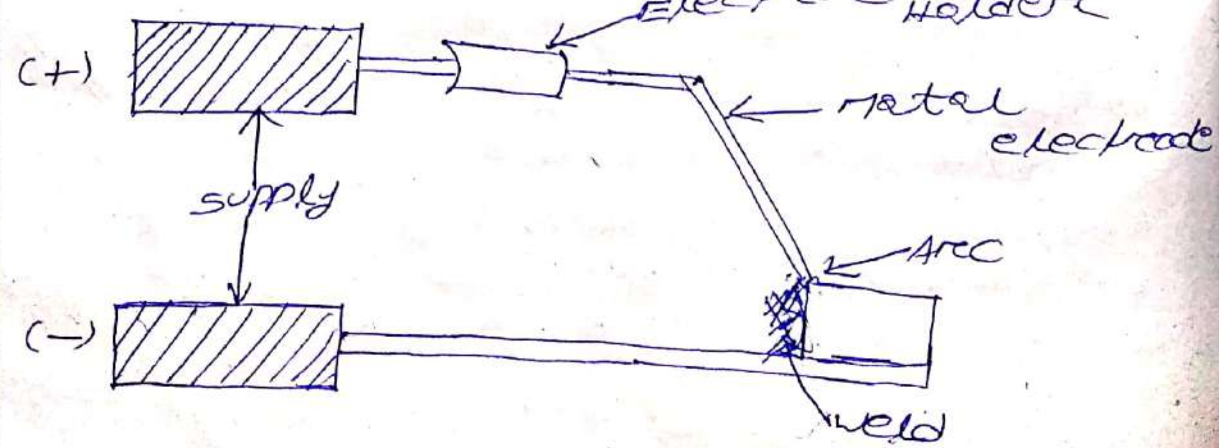
→ But when the current flows the voltage drop across the reactance coil reduces the voltage at the arc to the required value.

→ Reactance coil also control the flow of current which is done by adjusting the tapping in the reactance coil.

IMP

TYPES OF ARC WELDING

1. METAL ARC WELDING



→ In this method the metal Rod is used as an electrode and an arc is struck between the electrode and the work piece which respectively ~~form~~ from the two terminals.

→ In this case both AC and DC can be used

→ The work is suddenly touched by ~~a~~ the electrode and then separated by a small distance. this results in an arc between the electrode and the workpiece.

→ Due to high amount of heat produce by the arc the electrode as well as the part of the work piece melts.

→ After cooling it will give a strongly welded joint.

→ Temp. is about 3500°c between the electrode and the work piece.

2. CARBON ARC WELDING

→ This method of arc welding is normally used for welding coppers and its alloys.

→ For this type of welding only DC can be used.

→ The carbon electrode is kept -ve with respect to the work piece because if carbon in at possitive it has a tendency go in to the welded joints and causes brittleness.

→ The heat ~~form~~ from the arc forms a molten pool and extra metal required to make the weld is supplied by a filled rod of the same composition as that of the molten metal.

→ Two methods of carbon ~~are~~ arc welding are used

1. For ferrous metal flux is used to present oxidation.
2. In non. ferrous metal no flux is used.

3. ATOMIC HYDROGEN ARC WELDING

→ In this type of welding arc is strucck between two tungstone electrodes and hydrogen gas is passed through the work piece.

→ Due to high temp. of about 4000 °C hydrogen changes to its atomic form.

→ This atomic hydrogen will takes up the heat and travels to cooler region.

→ It gives of the heat in the cooler region i.e the work piece and again converts to moleculer form.

→ Thiss process ~~is~~ will continiously take place and large amount of heat will generated which will use to melt the work piece to be welded.

4. ARGON/HELIUM ARC WELDING

→ This method is used fore ~~heating~~ welding Al' alloys, magnesium and magnesium alloys.

→ And arc is strucked between electrode tungsten and the work piece and helium and argon gas is used to give an inert atmosphere so that oxidation of the welded joint does not take place.

2. RESISTANCE ~~HEATING~~ WELDING

It may be defind as the method in which sufficiently strong electric current is send through the two metals in contact to be welded bringing the two metal pieces in molten state. and applying a mechanical pressure in the axial direction to complete the joint.

→ The heat generated by the flow of electric current I through a resistance 'R' is given by $H = I^2Rt$

→ so to obtain a greatere heating effect current should be high because 'H' is directly propo- sitional to I^2.

→ For this region resistance welding requir- eds low voltage and high current.

ADVANTAGES OF RESISTANCE ~~HEATING~~ WELDING

→ It is a quick method to joining two metals.

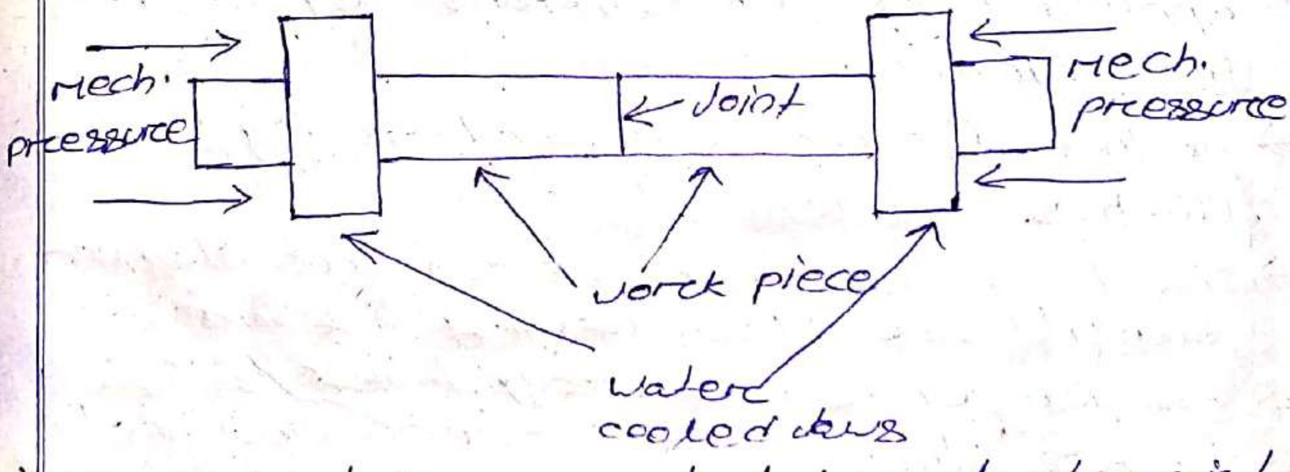
→ There will be no weestage of energy.

→ process can be easyly control

→ welding is consistently uniform.

TYPES OF RESISTANCE WELDING

1. BUTT WELDING



→ Here heat is generated by contact resist- ance between two components

→ The two components are braught together and pressure is applied along the axial direction

→ A heavy current is passed from a welding T/F having less no. of turns in the secondary winding.

→ which will creat the necessary amount of heat.

→ The metal at the ~~[illegible]~~ joint melts and produce the bluged joint.

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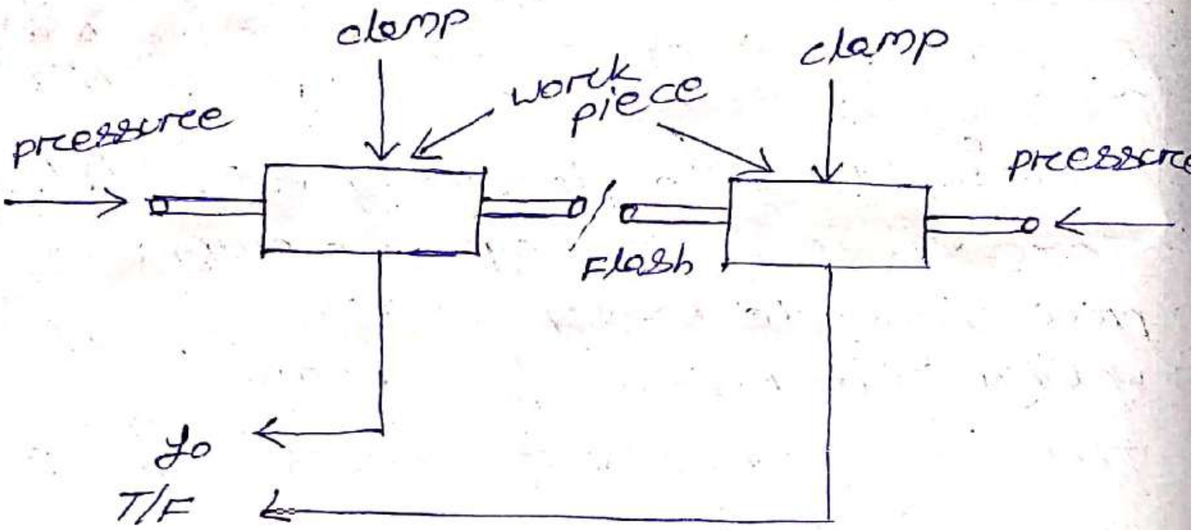
→ Ex – welding of pipes, rods, and wires.

2. FLASH WELDING



→ This is similar to butt welding except the difference that in this case current is applied to the parts before they are brought together.

→ so that when they will meet arcing or flashing will take place

→ The two pieces to be welded are clamped strongly in a flash welding. Machine.

→ The two parts are brought together and the resistance to the current flow heats the contact in surface.

→ As soon as the melts has be brought to its melting temp. current is shut off and considearable. pressure is apply.

→ During this process the squeezed molten metal give some spark or flash and hence the name is flash welding.

→ Ex – welding of rods and pipes together, production work etc.

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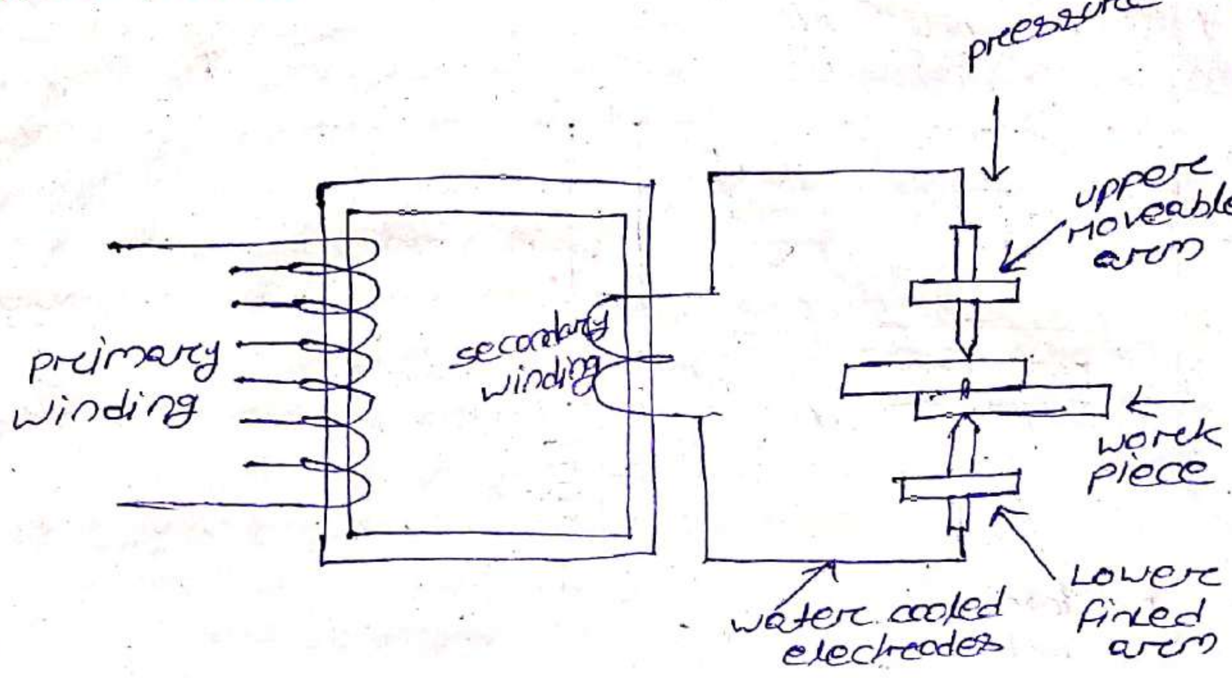
3- SPOT WELDING (IMP)



→ spot welding machine consist of a T/F to produce a high current at low voltage.

→ i.e electrode are connected that to the ends of secondary winding for leading the current to the work and applying necessary mechanical pressure.

→ Tapping is provided in the primary winding of the T/F to regulate the secondary voltage and thus the welding current.

→ In this process the metal to be welded are over lap and pass between two water cool electrode and an impulse of current is passed through the assembly.

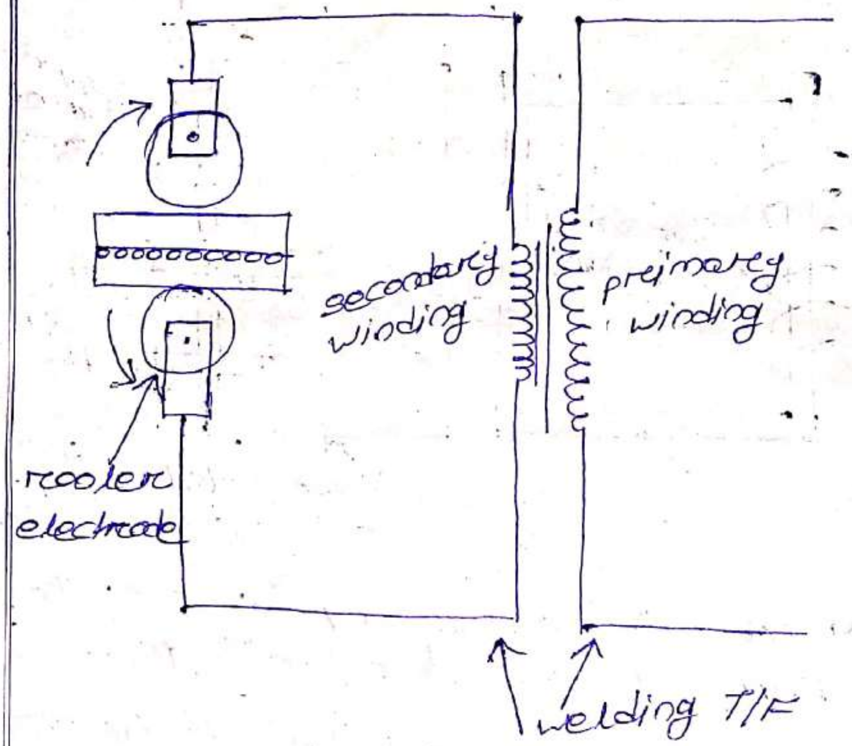
→ The metal in the zone of pressure gets heated up to fusion and joint thus made gets cooled under pressure.

→ For spot welding current is about 5000 A and voltage is about 3V.

→ The value of welding current, time for current flow and pressure between electrode tips are the main factors affecting the quality of spot welding.

→ Ex → welding of metal sheets

4. SEAM WELDING



→ It is similar to spot welding except that series of spot are produced by rooler electrodes. instead of tipped electrodes.

→ As the rooler travels over the metal the metal pieces are under pressure and current passing between the metal pieces heats then the fusion point and welding take place. This may be called as seams spot weld method

→ There are two type of seam welding
  a. continious seam
  b. Discontinious seam.

→ In continious seam uninterrupted flow of current is supplied to the electrodes so spots are continious.

→ In discontinious seam current to the electrode is turned off certain interval so spots are produced at intervals

5 PROJECTION WELDING

-> Here prodection are made on the ~~seet~~ sheet of metal in precised locations by a special set of dies.

-> After projections are formed, the raised portions on ~~the~~ one piece are pressed into contact with another piece and at ~~sae~~ same time a heavy current is passed through two pieces this high current melts and fuses the two pieces together.

CHAPTER-4

ILLUMINATION

RADIATIONS

→ The energy of an atom is constant as long as the electrons stays in a stationary orbit and atom is set to be in stationary state.

→ Radiation is produced when an electron falls from an outer stationary orbit to one nearer the nucleus.

→ When such a transition occurs, a single quantum or photon of radiations is emitted.

→ Thus the radiations from an atom is not continious but in the form of quantum whenever an electron moves from one stationary orbit to another.

→ But as we dealing with large no. of atoms the radiations seems to be contiņious in time.

→ Each photon may be considered to be assosiated with a wave which predicts how the photon will travel. and it is given by

$$V = \lambda f$$

where V = velocity of wave

λ = wavelength of wave (unit = Angstrom (A°) = 10^{-10} m, 10^{-8} cm)

f = frequency of wave

SPECTRUM OF LIGHT

→ The spectrum of light consist of 7 colours; Violet, Indigo, Blue, Green; Yellow, orange and Red denoted by VIBGYOR.

→ All these radiation have different wave length and frequency. above and below the radiations are ~~thit~~ ultraviolet and infrared radiations.

ILLUMINATION

when light falls on a surfece the phenomenon is called illumination.

→ Illumination makes a surfece more or less bright with certain coloure and it is the brightness and colour which are eyes see.

TERMS USED IN ILLUMINATION

1. LIGHT

It is defind as the rediant energy from a hot body causing visual sensation of eyes.

2. LUMINOUS ~~INTEN~~ FLUX(F) IMP

It is defind as the total quantity of light energy rediated or emitted per second frome luminous body in the form of light waves.

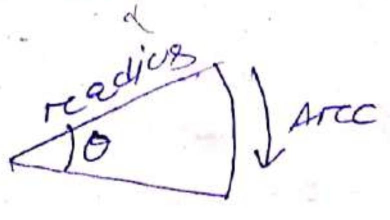
→ It is denoted by 'F' or 'ϕ'

→ unit : lumens.

3. READIANT EFFICIENCY/LUMINOUS EFFICIENCY(H) IMP

The ratio of energy emitted by the body in the form of light to the total amount of energy emitted is called luminous efficiency or readiant efficiency.

4. ~~PHASE~~ PLANE ANGLE (θ)



$\theta = \frac{Arcc}{radius}$

→ plane angle is subtended ~~that~~ at a point in the same plane by two converting lines.

→ unit: degree /Rediant.

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5 SOLID ANGLE (ω)

$$\omega = \frac{area}{(radius)^2}$$

→ A solid angle enclose a volume by infinity no. of line laying on a surface, and meeting at a point.

→ It is measured in steradians.

6. LUMINOUS INTENSITY

→ Luminous Intensity at any perticulare direction is the luminous flux emitted by the source per unit solid angle.

$$I = \frac{F}{\omega}$$

→ unit: lumen/steradians or candela

7. CANDLE POWER

→ It is the total light rendering capacity of a source in a unit solid angle.

or

→ It is defind as the no. of lumen given out by the source in a unit solid angle is a given direction.

$$\text{candle power} = \frac{\text{lumen}}{\omega}$$

8. LUMEN

$$\text{Lumen} = \text{candle power} \times \omega$$

→ It is defined as the amount of luminious flux given out in space represented by one unit solid angle by a source having an intensity of 1 candle power in a given direction

9. ILLUMINATION(E)

$E = F/A$

→ when light falls upon the surface the phenomenon is called illumination.

→ It is defind as the no. of lumens falling on the surface per unit area so.

$E = F/A$ unit $= \frac{lumen}{m^2} = lux$

10. M.S.C.P (IMP)

→ It is defined as the average of candle power in all direction and in all plane from the source of light.

→ MSC.P stands Mean sperical candle power.

11. MHCB (IMP)

→ Means horizontal candle power

→ It is defind as the average of the candle power in all direction only in Horizontal plane containing the source of light.

12. MHSCP (IMP)

→ Mean Hemi-sperical candle power

→ It is defind as the average of the candle power in all direction. above and below the Horizontal line passing through the source of light

13. BRIGHTNESS/LUMINANCE

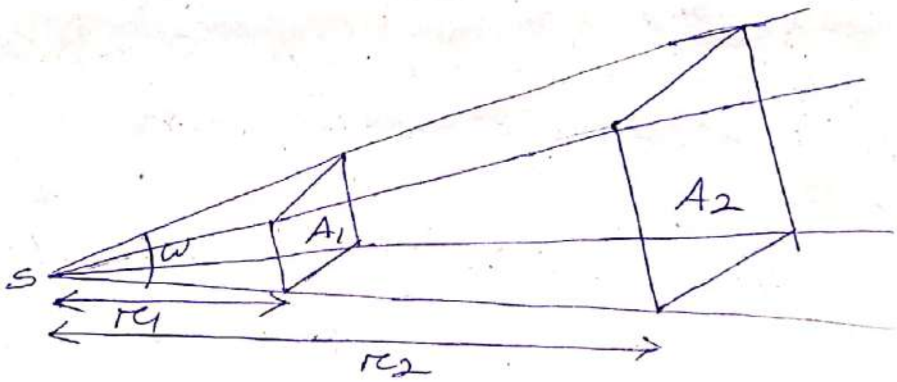
→ It is defind as the luminous intensity per unit projected area of either a surface source of light or reflecting surface.

LAWS OF ILLUMINATIONS (IMP)

→ There are two laws of Illumination

1. INVERSE SQUARE LAW

→ Its state that the illumination of a surface is inversly propositional to the square of the distance between the source and the surface provided that the distance between the source and the surface is sufficiently ~~that~~ large



→ consider a point source s having intensity I = lumen/steradian so any surface enclosed by solid angle(ω) we receive total flux

$$F = I \times \omega$$

and $\omega = \text{Area}/(\text{radius})^2$

For surface area 'A_1'

Flux on surface A_1

$$F = I \times \omega$$
$$= I \times \frac{A_1}{r_1^2}$$

Illumination

$$E_1 = F/A_1 = \frac{I}{r_1^2} \quad \text{———} (1)$$

For surface area 'A_2'

Flux on surface A_2

$$F = I \times \omega$$
$$= I \times \frac{A_2}{r_2^2}$$

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Illumination

$$E_2 = F/A_2 = \frac{I}{r_2^2} \quad \text{———— (2)}$$

so From (1) and (2)

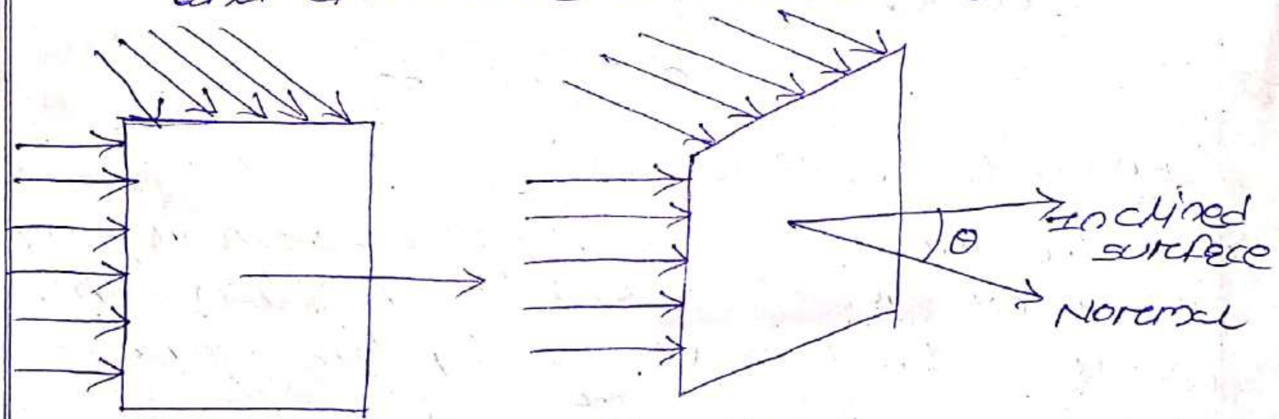
$$\frac{E_1}{E_2} = \frac{(I/r_1^2)}{(I/r_2^2)} = \frac{r_2^2}{r_1^2}$$

2. LAMBERT'S COSINE LAW

It states that illumination of a surface varies directly as the cosine of the angle between the normal to the surface and direction of incident light.

$$E \propto \cos\theta$$

θ = Angle between normal to the surface and difference of inclined light



(Normal surface) (Inclined surface)

POLAR CURVE (IMP)

→ The luminous intensity of any practically lamp is not uniform in all direction due to its un-symmetrical shape.

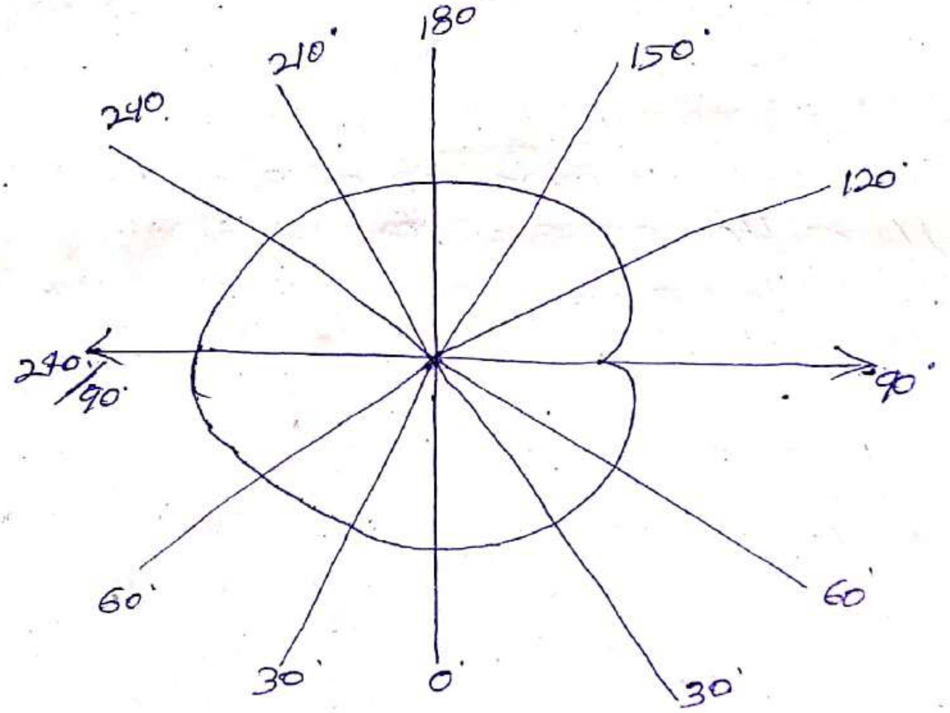
→ The luminous intensity in all direction can be represented by a curve called polar curve.

→ There are two types

1. Horizontal polar curve
2. vertical polar curve.

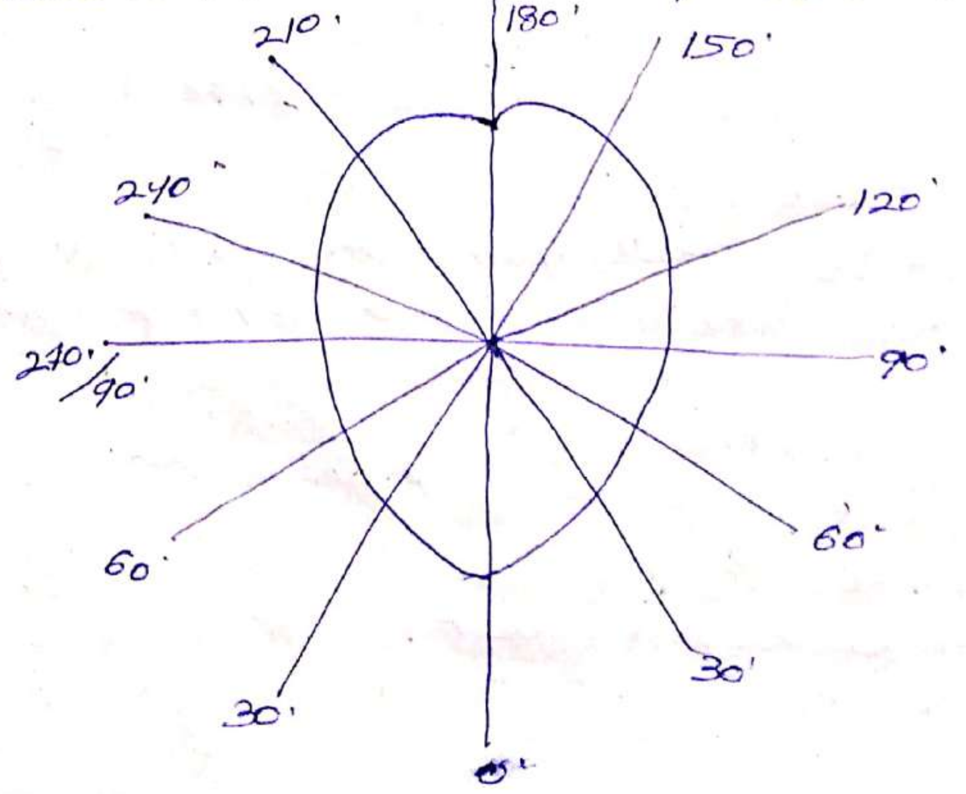
1. HORIZONTAL POLAR CURVE

If the luminous intensity in a Horizontal plane passing through the lamp is ploted against angular position then this curve is called Horizontal polar curve.



2. VERTICAL POLAR CURVE

→ If the luminous intensity in a vertical plane is ploted against the angular position then the curve is known as vertical polar curve



MAINTENANCE FACTOR IMP

Due to eccumulation of Dust, smoke, dirty on the lamps they emitted less light as compair to that they ~~emit~~ emmit when there perfectly new.

→ The ratio of illumination under normal working condition to the illumination when the lamp are perfectly clean or new is called maintenance factor.

$$\text{Maintance Factor} = \frac{\text{Illumination of a lamp under normal working condition}}{\text{Illumination of the lamp when everything is perfectly clean.}}$$

→ The value of the maintance factor will always be less than one.

DEPRICIATION FACTOR IMP

→ It is the reciprocal of maintenance factor

→ It is defind as the reatio of illumination of the lamp when every thing is perfectly clean to illumination of a lamp under normal working condition.

→ $$\text{Depriciation Factor} = \frac{\text{Illumination of the lamp when everything is perfectly clean}}{\text{Illumination of a lamp under normal working condition.}}$$

→ The value of the depriciation factor will always be greater than one

DESIGNING OF LIGHTING SCHEME

1. SPACE-HEIGHT RATIO

→ It is defind as the ratio of horizontal distance between two adjucent lamps and the mounting height of the lamps.

→ 0.8 → 1.2 → Normal lighting

→ 1 — 2 → Reflecting lighting

2. UTILISATION FACTOR

→ ~~Total~~ The total luminous flux radiated out by the source is not utilised wholey on the working surface and is given by utilisation factor.

$$U.F = \frac{\text{lument utilised in the surface}}{\text{Total lument radiated from the lamp}}$$

→ For direct lighting the value of U.F should between 0.25 ~~to~~ to 0.5 and indirect lighting is 0.1 to 0.3

3. DEPRICIATION FACTOR

previous page

TYPES OF LIGHTING SCHEME

Depending on whether the source throw light directly over the surface or it reaches the surface after reflection from other surface lighting scheme can be classified in to 4 types.

1. Direct lighting
2. Indirect lighting
3. semi direct lighting
4. semi indirect lighting.

1. DIRECT LIGHTING

In this case the light from the source is thrown directly over the surface to ~~the~~ be iluminated

2. INDIRECT LIGHTING

In this case no light reaches directly from the source on the surface to be illuminated.

→ Here the illumination of the surface takes place through reflecting light.

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3. SEMI DIRECT LIGHTING

-> 60% of light reaches the surface comes directly from the surface and 40% of the light comes through reflecting light.

4. SEMI-INDIRECT LIGHTING

-> 60% of light is thrown on the surface through reflecting light and rest 40% comes directly from the sources.

Depending on the manner sources are mounted to illuminate specific object lighting schemes are of two type.

1. Local lighting
2. General lighting.

1. LOCAL LIGHTING

If the light is confined to illuminate a perticular object it is called local light.

-> Ex: study light, light for lathe machine etc.

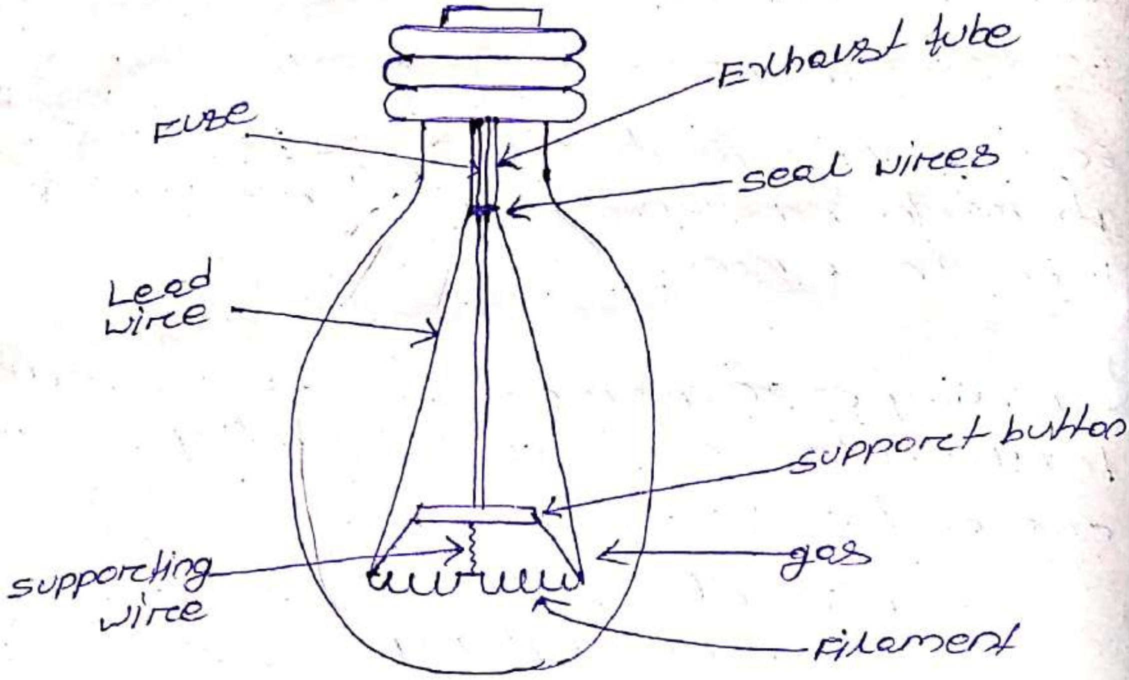
2. GENERAL LIGHTING

An addition to local lighting general lighting is done for proper illumination of the ~~sources~~. surface.

TYPES OF LAMP

1. Filament lamp
2. Incandescent lamp
3. Fluorescent lamp
4. Mercury vapour lamp
5. sodium vapour lamp
6. Gas Discharge lamp
7. Neon sigh Lamp

1. FILAMENT LAMP



- Filement material used as are generally carbon & tungsten.
- Mostly tungsten is used as the filament material because it have most of the char. required by a filament material.
- The light emitted by filament lamp is proportional to 12 power of absolute temp (T^{12}) and thats why lamps are run at high temp as far as possible.
- If the space in the lamps is replaced with an innert gas tungsten filament can reach a temp of 2400 kelvin without evaporation.
- Due to high temp loss of heat will occure and thus we use gases like Argon or Nitrogen in the filament lamp.
- convection losses are minimised by the spiral arrangement of the filament.

→ During manufacturing all air is pumped out of the glass envelope to prevent filament burning when operating.

→ Lamps large than you are filled with inert gas like argon and Nitrogen to reduce evaporation of tungsten

→ Tungsten filament.

$$\text{light output} \propto V^{4 \text{ to } 5}$$

EFFECT OF VARIATION OF VOLTAGE ON WORKING OF FILAMENT LAMP

→ The filament lamp are generally constructed for operation along constant supply voltage.

→ But a variation of ± 6% voltage at consumer terminal is permitted the operating voltage should be between 212V to 224V.

2. INCANDESCENT LAMP

→ They are also known as filament lamp.

→ The incandescent lamp operate by the principle of Incandescence i.e when a current flows through a wire both light and heat energy is produced.

→ When the filament is Red hot it emits more heat as compaire to light.

→ When the filament is white hot the amount of light radiation is more than the heat radiation

→ Materials used for filament ~~resistivity have~~ should ~~be~~ have the following properties.

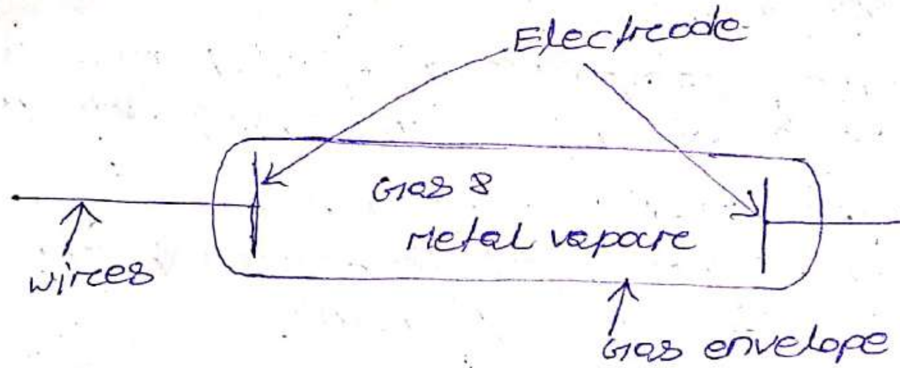
1- It should have high melting point.
2- It should have high resistivity
3- It should have low temp. co-efficient
4- It should have low vapour pressure.
5- It should be mechanically strong to withstand vibration during normal use.

→ It should be ductile so that it can be drawn into very thin wires.

→ Material used for filament are carbon, tungsten, osmium and tantalum filament lamps.

→ Tungsten is used mostly because it posess all the above properties.

GASEOUS DISCHARGE LAMP



→ Gases are normaly poor conductors at atmospheric and high pressure.

→ When a suitable voltage known as ignisation voltage is applied across the two electrodes discharge of gases will take place along with electromagnetic ~~ree~~ radiation.

→ The value length of the radiation depends on the gas, its pressure and the metal vapore used in the lamp.

→ Once the ionisation get started it has a tendency to increase continiously accompanied by a fall in the ckt resistance.

→ In order to limit the value of current to a save ~~fo~~ value a chock or Ballast is used.

→ The chock performs two function i.e providing the ignisation voltage ~~initially~~ sufficiently and limiting the value of current.

→ Due to the use of chock the power factor become poor i.e 0.3 to 0.4 so in order to improve the power factor a condenser is used.

→ The production of light by these lamps is based on the phenomenon of excitation and ionisation in a gas or vapour.

→ If a potential difference is applied to two electrodes placed in a gas having large no. of free electrons.

→ The electron ~~th~~ will be attracted towards the +ve electron and the velocity of this electrons depend upon the potential gradient.

→ During the motion towards the +ve electrode. the electrons will strike will other atom. and the following result may be produced.

i. ELASTIC COLLISION

→ The electron may be bounced off the atom it strikes and there may be no change in the velocity.

→ This happens when the striking electron has small amount of kinitic energy.

ii EXCITATION

If the electrons has equared kinitic energy above certain critical value. the collision may caused one of the electron to jump from its normal orbit to another orbit.

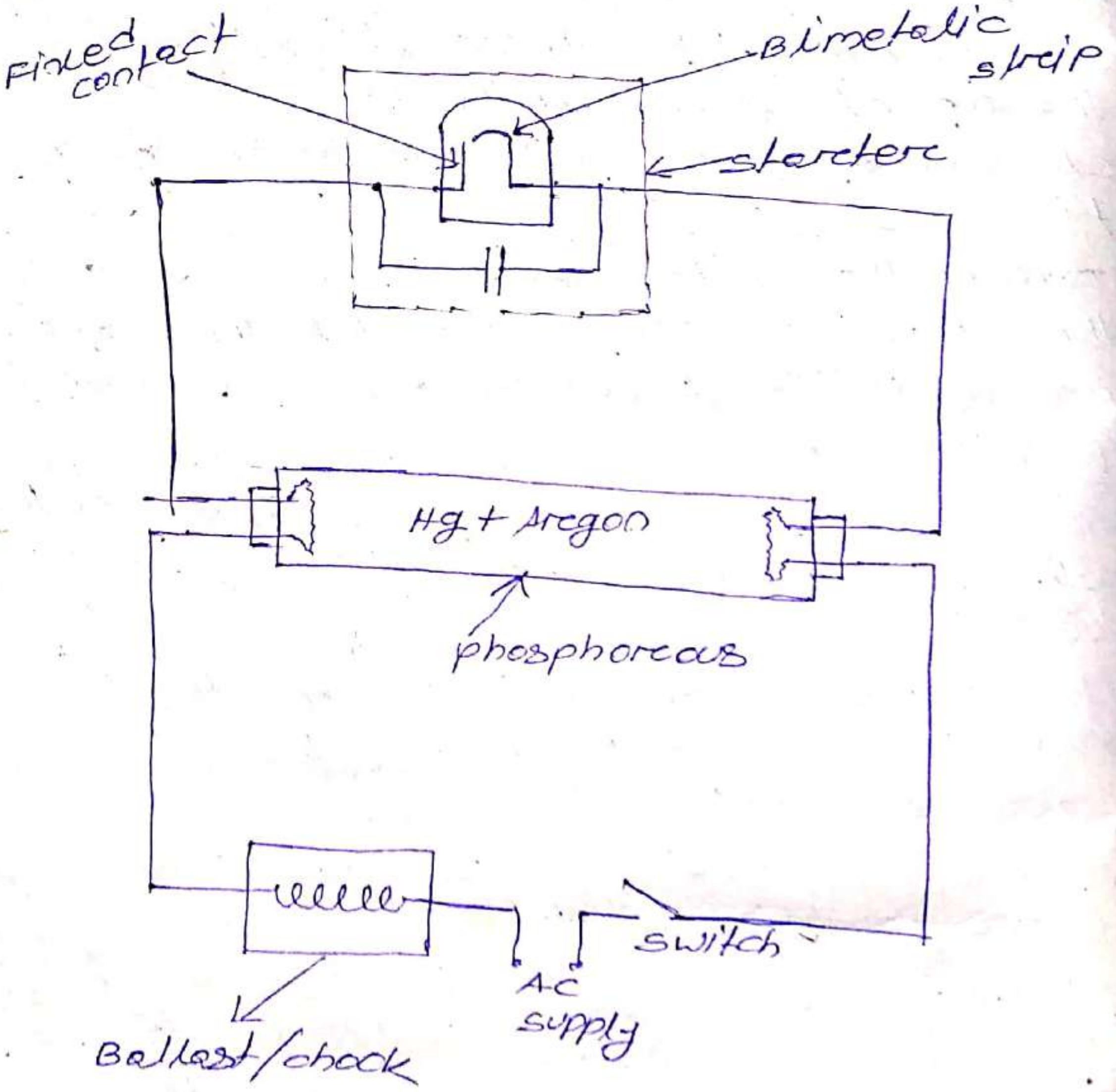
→ The coaliting electron imparts its kinitic energy to the atom that it strikes and the atom is said to be in the ~~exeiotation~~ excitated state.

iii IONISATION BY COLLISION

→ If the kinitic energy of the coliting electron is sufficiently large it is completely known out and its electron from its orbit and the electron will now behave like a free electron and may produce more no. of free electron by collision.

→ A large no. of free electrons thus produce a heavy current and an electric arc may result this phenomenon is called ionization by collision.

FLUORESCENT LAMP:



→ A fluorescent tube is a low weight mercury vapour lamp that uses principle of Fluorescence to deliver visiable light.

→ An electric current in a gas energised mercury vapour which deliver ultraviolet radiation through discharge process and the ultraviolet radiation causes the phosphorous coating of the inner of the tube to rediate visiable light

-> we connect one ballast, one switch and the supply in series then we connect the freaciorescent tube and a starter approx it.

OPERATION

When we switch on the supply full voltage comes across length and across the starter through the balast.

-> But at that instant no discharge happen i.e no lumen output from lamp.

-> At full voltage first glow discharge is established in the starter becalse the electrode gap in the neon bulb of the starter is much lesser than the electrode gap of florescent lamp

-> The gas inside the starter gets ionized due to full voltage and heats the bimetalic strip so that bimetalic strip will bend and connect the fixed contact.

-> Now current starts flowing through the starter. As soon as the current starts flowing the voltage across the neon bulb that reduced because the current produces the voltage drop across the ballast.

-> At reduced voltage across the neon bulb of the starter there will be no more gas discharge taking place hence bimetalic strip that cools and breaks away from fixed contact.

-> At the breaking the current get interrupted and a large voltage surge comes across the ballast i.e $V = L\frac{di}{dt}$ this high voltage surge comes across the tube light electrodes and strike the penning gas mixture.

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→ Gas discharge will gets started in the fluorescent lamp and current gets path to flow through the fluorescent lamp it self.

→ During discharging the penning gas offers a low resistance path then the resistance of the starter.

→ The discharge of mercury atom produce ultraviolet radiation which interm excite the phosphor powder coating to produce visible light.

→ starter gets inactive during glowing of the tube because no current flows through the starter in that condition.

NEON LAMP

→ It consist of a gas tube filled with neon gas and small % of Helium.

→ The two electrodes in the ~~gas~~ glass bulb are of pure iron spaced few mm apart.

→ These lamps are operated on 110V AC or 150V DC supply.

→ There very small as compaire to fluorescent lamp.

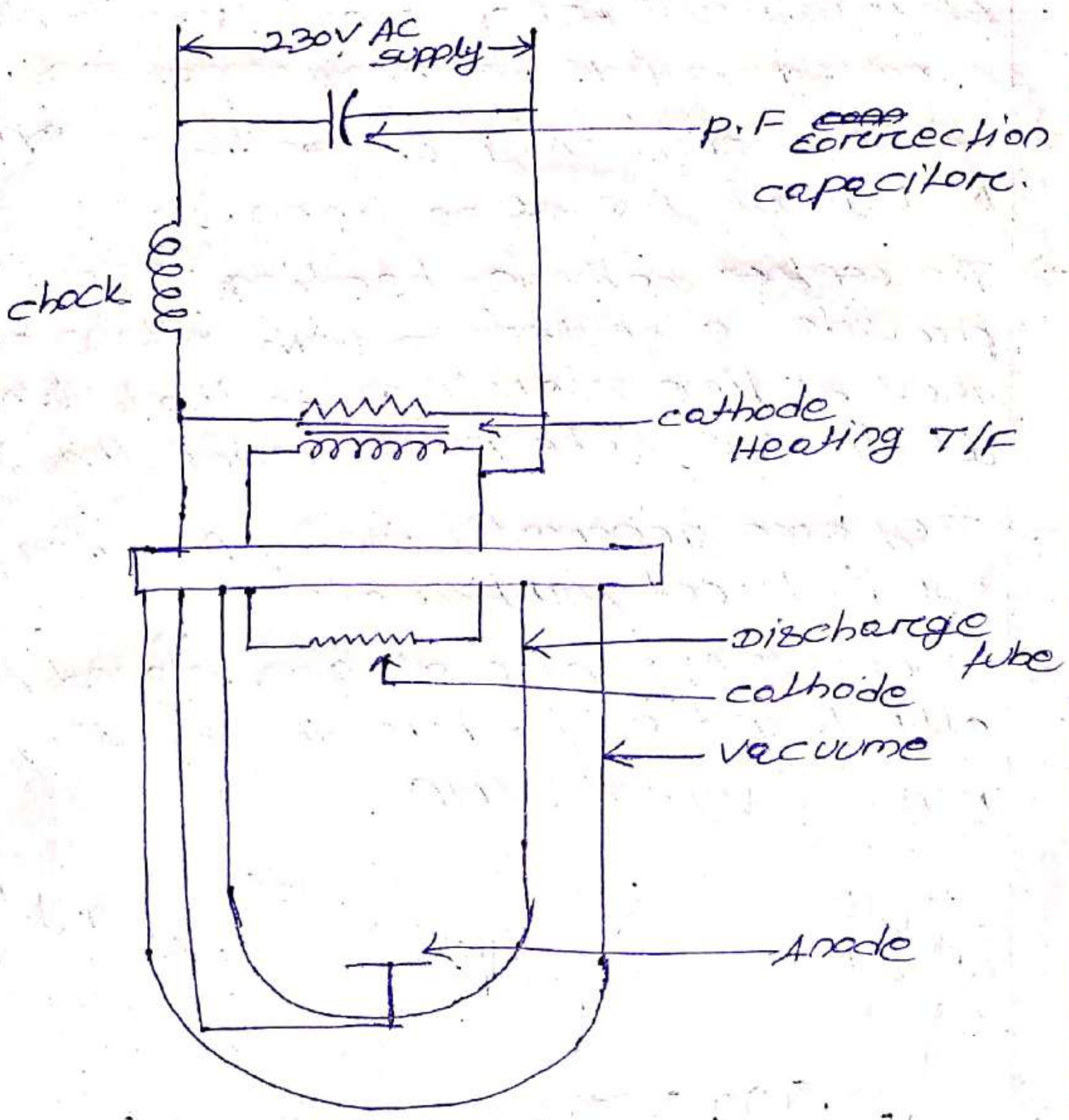
→ They give orange pink coloured light.

→ Its luminous efficiency is about 15 lumen/watt and power consumption is about 5watt.

→ They are used in indicator lamp and night lamps.

SODIUM VAPOUR LAMP

→ It is consist of an inner 'U' shaped glass tube made of high resistance glass and contains ~~a~~ ~~some~~ small amount of metalic sodium, Neon gas and two electrodes i.e anode & cathode.



→ The inner tube is enclosed of an outer glass tube of 'U' shape.

→ The gas tube is of 'U' shape because long discharge path are necessary.

→ When supply give to the ~~load~~ lamp discharge take place in the neon gas ~~fast~~ First Red-orange glow produces.

→ The metalic sodium gradually vapourize and then ionizes there by producing a light of yellow colour.

→ The lamp is also called monocromatic lamp because it emmits a light of yellow colour of wave length ~~[illegible]~~ 5000 Å units.

→ This lamps takes about 5-6 minuits for starting and takes about 15 minuits for comming in full working condition.

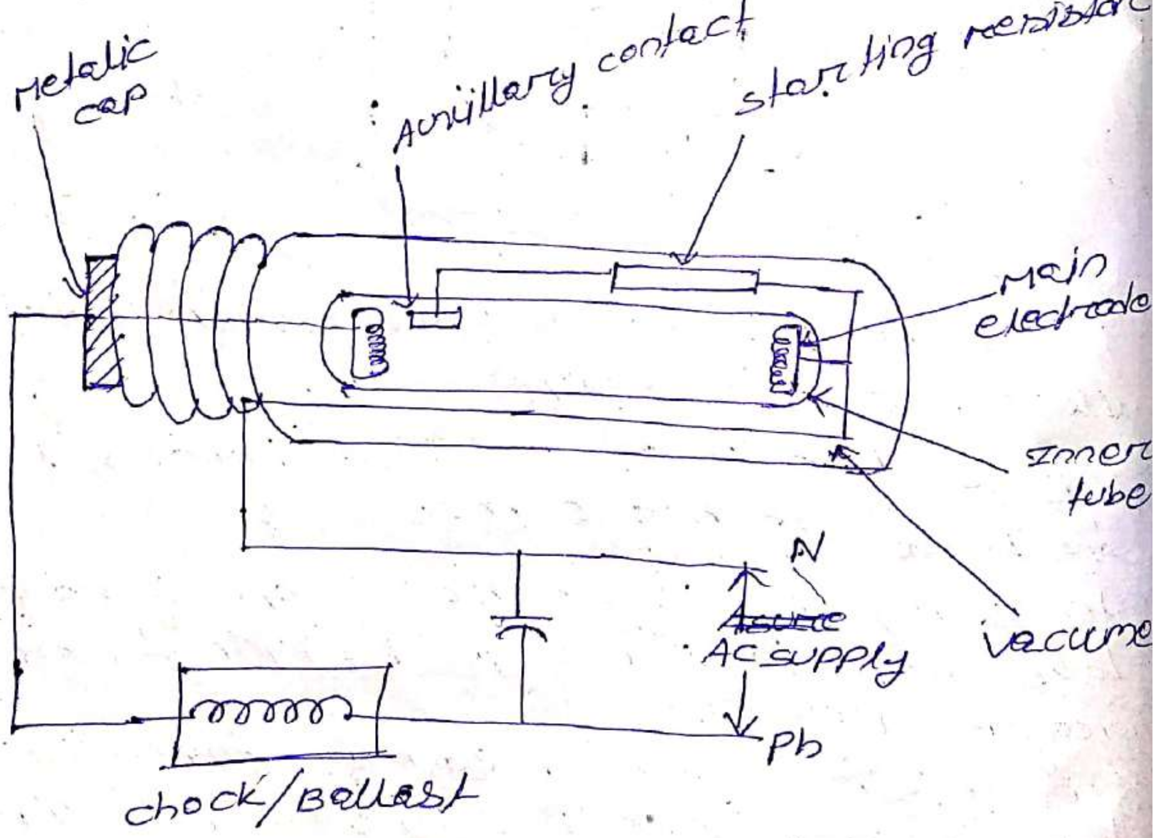
→ Luminous efficiency of sodium vapour lamp is highest i.e 50 lumen/watt

→ The cathode heating T/F is used to provide a high voltage of about 480V at time starting so that luminous discharge take place inside the tube.

→ They are generally used of highway lighting, street lighting etc.

→ These lamps are always placed horizontally to get a proper discharge path

MERCURY VAPOUR LAMP



→ The tube containing mercury vapour is made off hard glass the inner tube contains two main electrode ~~which is placed close to one of the main~~ made up tungsten wire, starting electrode which is placed close to one of the main electrode and gas mixture mercury (Hg) and argon (Ar)

→ The outer glass tube protect the inner glass tube from comming into direct contact with atmospheric temp variation.

→ The outer tube also absorves the ultraviolet radiation from the inner tube.

→ when ckt is energized the supply voltage appears between main electrode and Auxillary electrode.

→ The argon gas in between this two electrode it is immediatly ~~two electrode~~ ionised and a small glow appears between these electrode current starts flowing and results in building of pressure due to heating of mercury incondensed form..

→ ~~H~~ ultimately the medium between the main electrode is ionized and the current start flowing between the two main electrode.

→ The time taken during starting of the lamp is about 5-6 minuit.

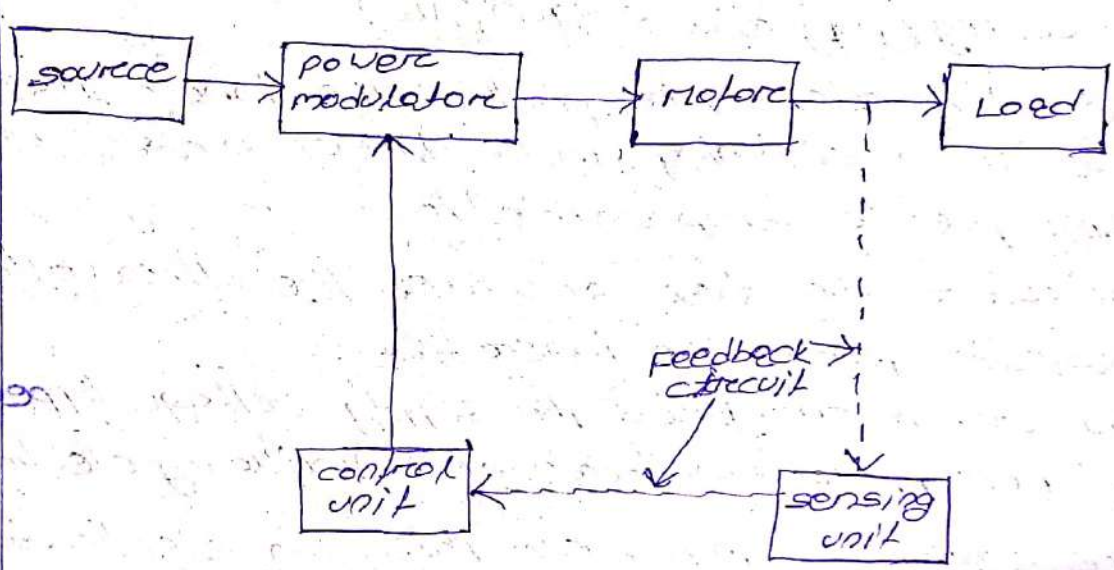
→ This lamp will give a ~~blues~~ bluish pale colour which gives it on natural appearance to the ~~be~~ living objects.

CHAPTER-5

INDUSTRIAL DRIVES

ELECTRIC DRIVE

An electric drive is defind as a form of machine equipment design to convert electrical energy to mechanical energy and provide electrical control of the process

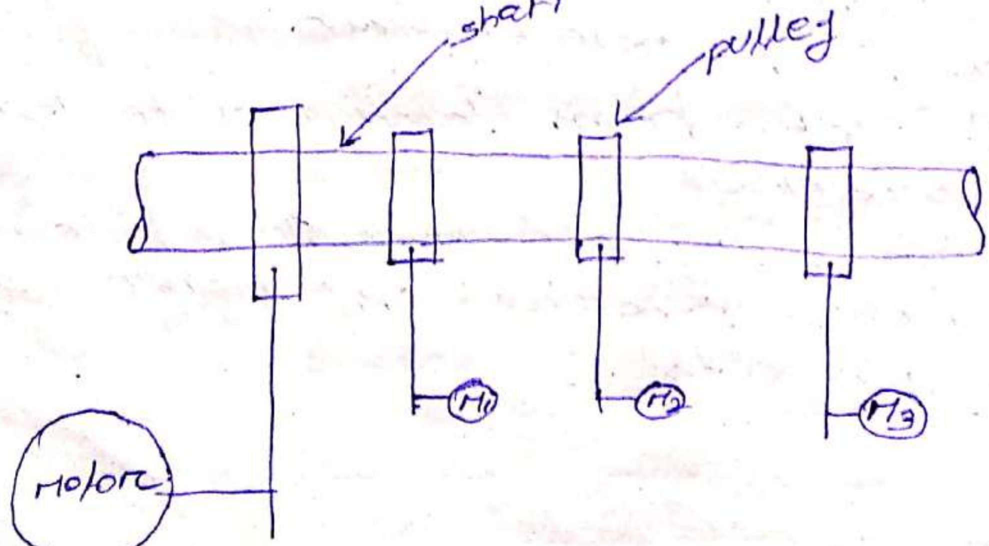


CLASIFICATION OF ELECTRIC DRIVES

Electric drives used in industry may be divided in to three types

a) Group drive
b. Indivisual drive
c. Multimotor drive.

a. GROUP DRIVE



→ In this drive one motor is used as a drive for two or more than two machines.

→ The motor is of bigger size and is connected to a long shaft on which belts and pulleys are connected to run other machines it is also called line shaft drive.

ADVANTAGES

→ This type of drive is economical because single motor of large capacity cost less than the cost of no. of small motors of the same total capacity.

DISADVANTAGES

→ In case of fault in the motor the operation of all the machines will stops

→ If at a certain instants all the machine are not operate then the motor will be operating low capacity. there by decreasing the efficiency of the system.

→ It is not possible to install a new machine

2. INDUSTRIAL DRIVES

→ In this type of drive a single electric motor is used to drive one individual machine.

→ The cost will be more than the group drive because of no. of motors but each operator has complete control of its machine.

→ If there is a fault in one motor this will not effect the production of industry.

3. MULTIMOTOR DRIVE

It consist of a several individual each performs different function and are a part of big, complicated system.

→ Ex → cable manufacturing unit, metal cutting machine, paper making M/c etc.

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ADVANTAGES OF ELECTRIC DRIVE

- Cost is low as compeire to othere system of drive.
- The system is more simple and clean
- The control is very easy and smooth
- Maintenance cost is quite low
- Treansmission of powere from one place to anothere can be done with the help of cables instead of ~~leg~~ long shafts etc.
- It can be started at any time without delay in time.
- Facility for remote control.

DISADVANTAGES

- This dreive system is ~~restrike~~ tied only up to the electreified aree.
- Failure in supply for a few minutes may paralyse the whole system;
- Condition arising under short cut, lickage from conductore and breakdown overe head conductor may lead to certain accidents.

GROUP DRIVE Vs INDIVISUAL DRIVE

During selecting a dreive first it should be determined wheather the dreive should be indivisual or group dreive.

ADVANTAGES OF INDIVISUAL DRIVE

- Failure of indivisual dreive will not effect the smooth working of different M/c.
- There is no necessary to shaft
- Work at good powere factor
- Efficiency is high
- Machine can be fitted whereever convinient
- Useful when constant space is required.
- Most suitable fore dreiving heavy M/c such as creane, lift, hoist, etc.

DISADVANTAGES OF INDIVISUAL DRIVE

-> cost is higher than group drive
-> operator have to control the speed of every motor.
-> Requirement of space will be higher.

ADVANTAGES OF GROUP DRIVE

-> Initial cost of group drive is less as compair to indivisual drive.
-> Group drive system is useful because all the operation can be started or stop simultaneously
-> Less space is required in group drive as compair to indivisual drive.
-> Required less maintenance as compair to indivisual drive.

DISADVANTAGES OF GROUP DRIVE

-> It has low power factor. ~~If~~
-> If all the Machines are not working simultaneously the main motor will work at reduced capacity and thus efficien~~ty~~cy decreases.
-> The main motor will fail the whole system will come to standsteel.
-> It does not provide constant speed.
-> The group drive is not suitable for driving heavy M/c such as crane, lift, hoist etc.

CHOICE OF ELECTRIC DRIVE

1. Requirement Related To Source
-> Type of source and it capacity.
-> Magnitude of ~~power factor~~ voltage, power factor, voltage ~~fluc~~ fluctuation, Harmonics etc.
2. steady state char. Requirement
-> speed torque char.
-> speed Regulation
-> Efficiency
-> speed range
-> Duty cycle.

3. Transient Requirement

→ starting, breaking, values of oscillation and deoscillation, Reversing performance etc.

4. capital & Running cost

5. Environment and location.

6. Reliability

7. space & weight restriction

STARTING & RUNNING CHAR. OF DC & AC MOTORS

→ starting char. is related to torque and running char. is related to speed.

STARTING CHAR. OF DC MOTOR

1. DC SHUNT MOTOR

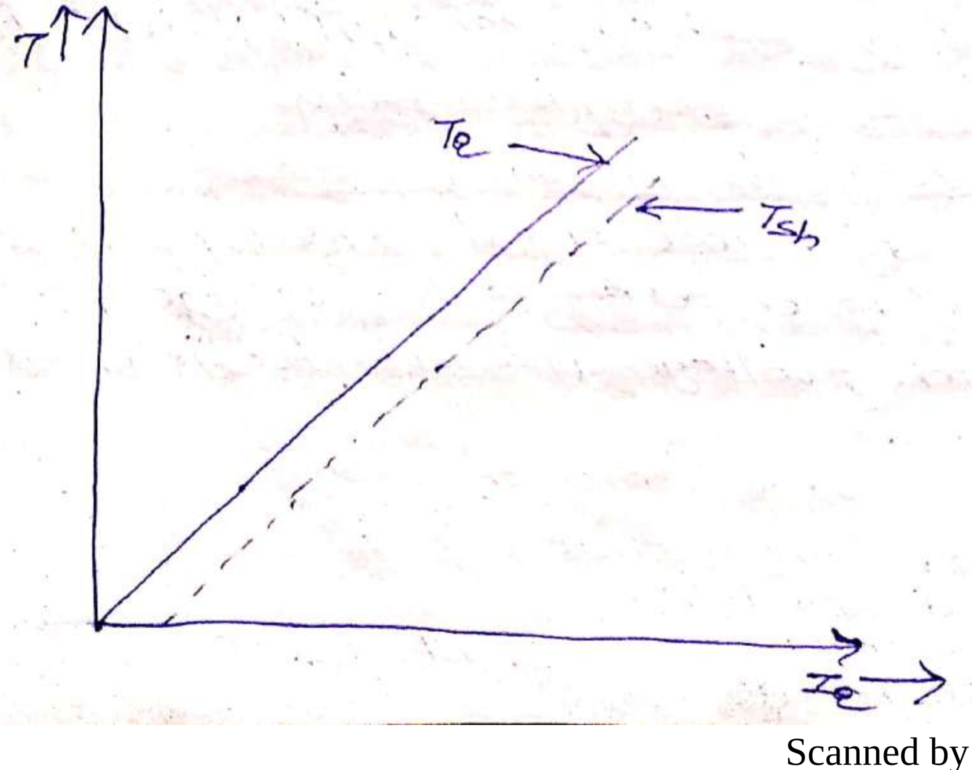
→ we know that $T \propto I_a \phi$

→ In case of shunt motor the field winding is supplied from constant voltage so flux(ϕ) is constant ~~since~~

since ϕ = constant

$T \propto I_a$

→ so the curve is straight line starting from origin



→ From this curve is clear that a very large current is required to start a heavy load so a shunt motor should to not be started on heavy load.

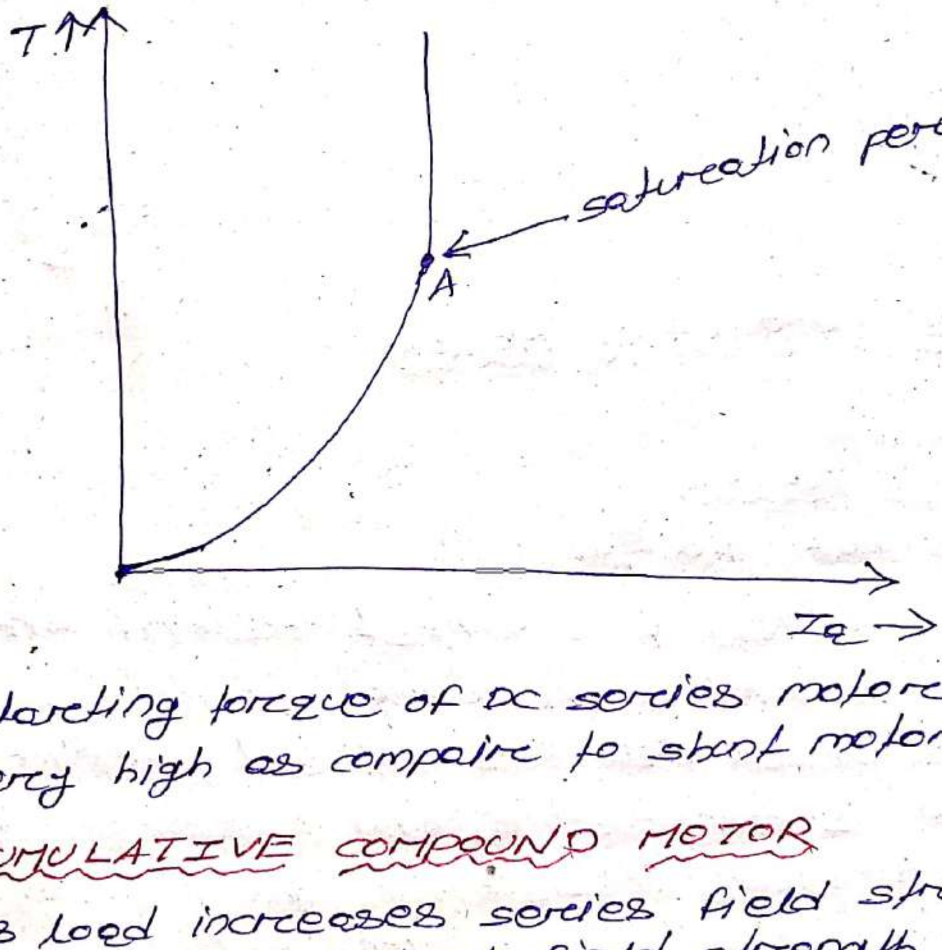
2. DC SERIES MOTOR

Here current passing through the field winding is same as that of armature current. Hence ϕ increase with I_a upto magnetic saturation

$$T \propto I_a^2$$

After magnetic saturation ϕ is constant

so $T \propto I_a$



→ starting torque of DC series motor will be very high as compare to shunt motor.

3. CUMULATIVE COMPOUND MOTOR

→ As load increases series field strength increases but shunt field strength remain constant. so the total flux is increased and hence torque is increased.

→ Torque produced by compound motor is greater than that of shunt motor and less than that of series motor for a given armature current.

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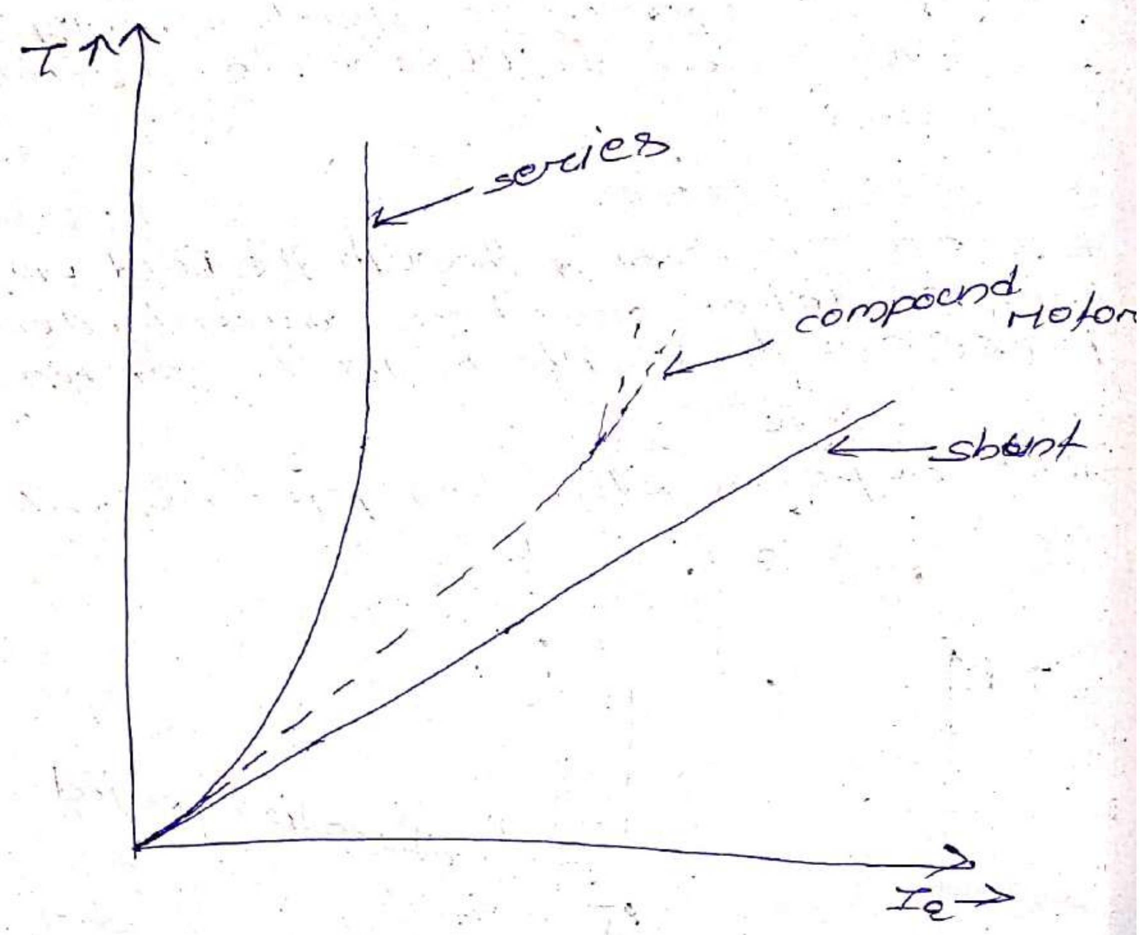


RUNNING CHAR. OF DC MOTOR

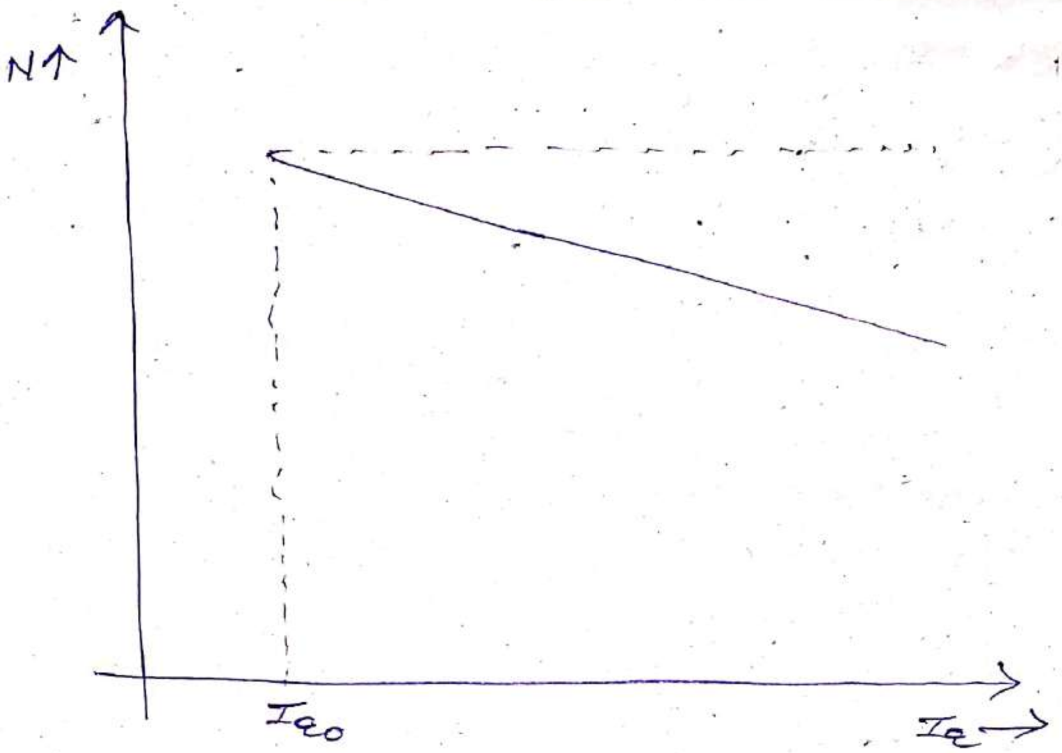
1. $N \sim I_a$

2. DC SHUNT MOTOR

we know that $N \propto \frac{E_b}{\phi}$

→ For shunt motor ϕ is almost constand and also E_b constant under normal condition. so speed is ~~almost~~ also constant. But practically when load is connected E_b and ϕ decreases due to armature resistance drop and armature reaction drop respectivly.

→ However E_b decreases more than ϕ so speed of the motor decreases slightly with load.



b DC SERIES MOTOR

→ we know $N \propto \frac{E_b}{\phi}$

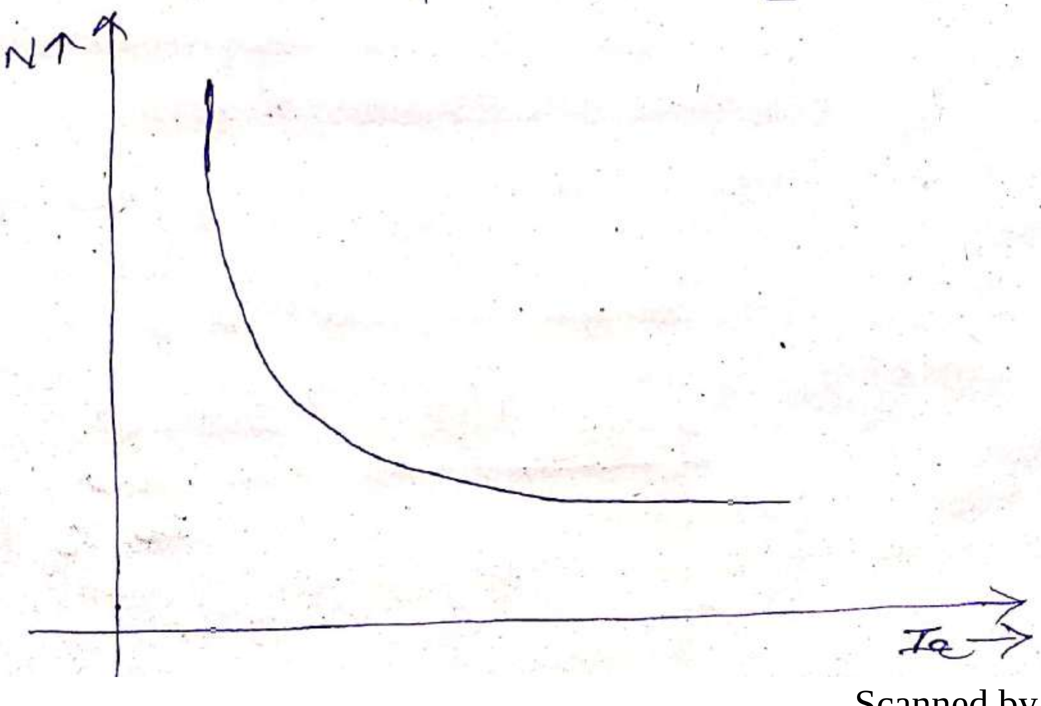
$$N \propto = \frac{V - I_a(R_a + R_{se})}{\phi}$$

→ when armature current (I_a) increases E_b decreases due to drop $I_a(R_a + R_{se})$

→ But we increasing I_a field current increases and hence flux increases.

→ However $I_a(R_a + R_{se})$ drop is very small and may be neglected so

$$N \propto \frac{1}{\phi} \Rightarrow N \propto \frac{1}{I_a}$$

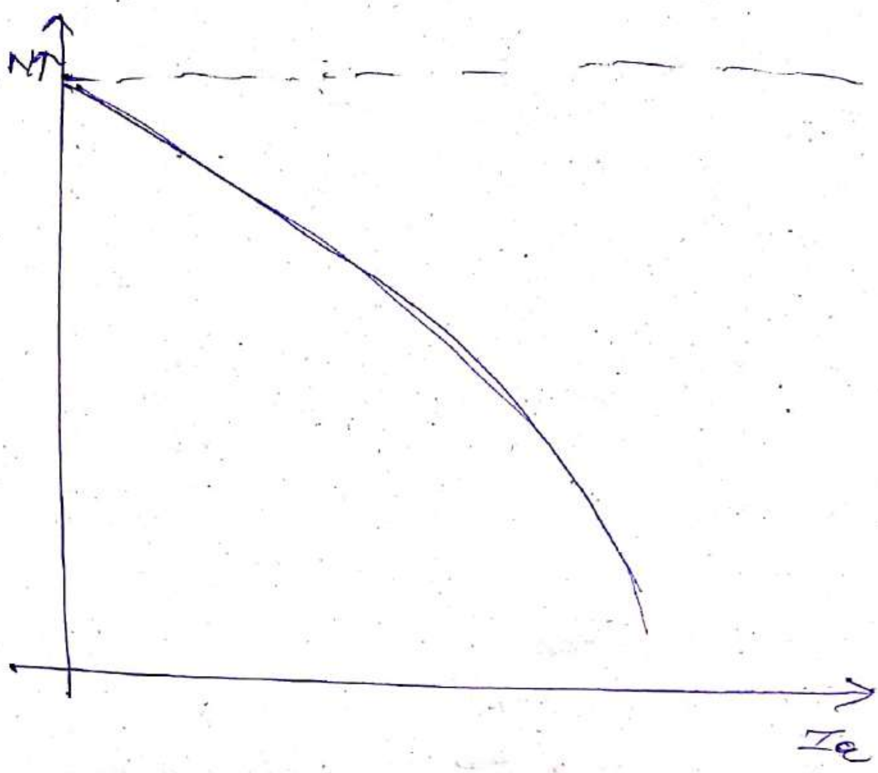


c. CUMULATIVE COMPOUND MOTOR

$N \propto \frac{E_b}{\phi}$

$N \propto \frac{1}{\phi}$

$N \propto E_b$

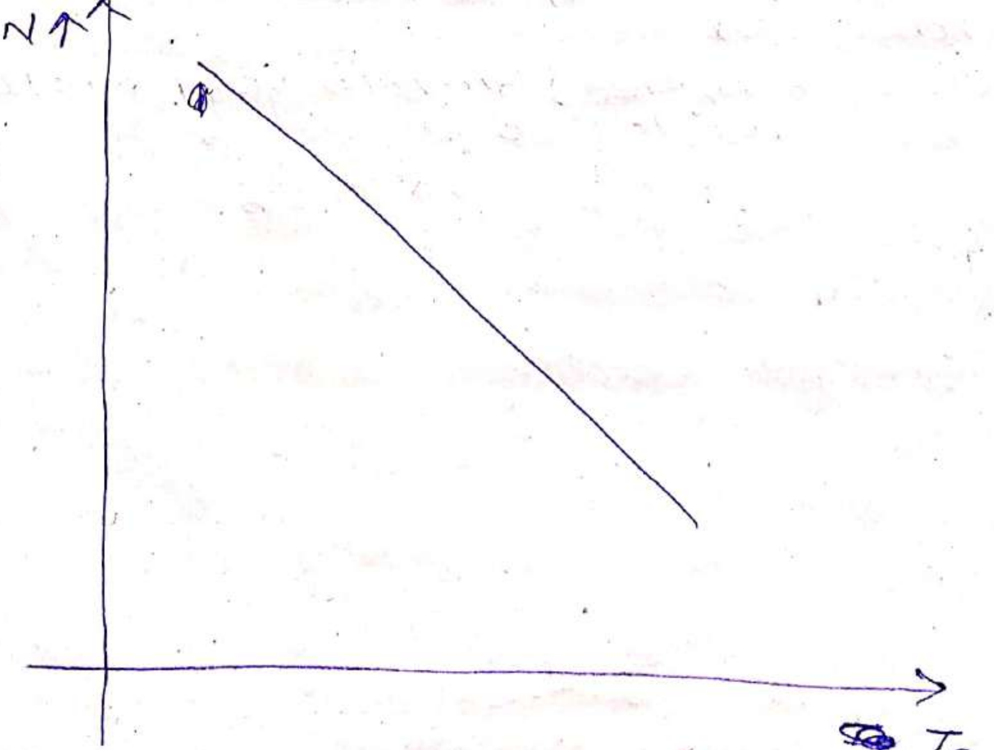


2. ~~N ∼ I_a~~

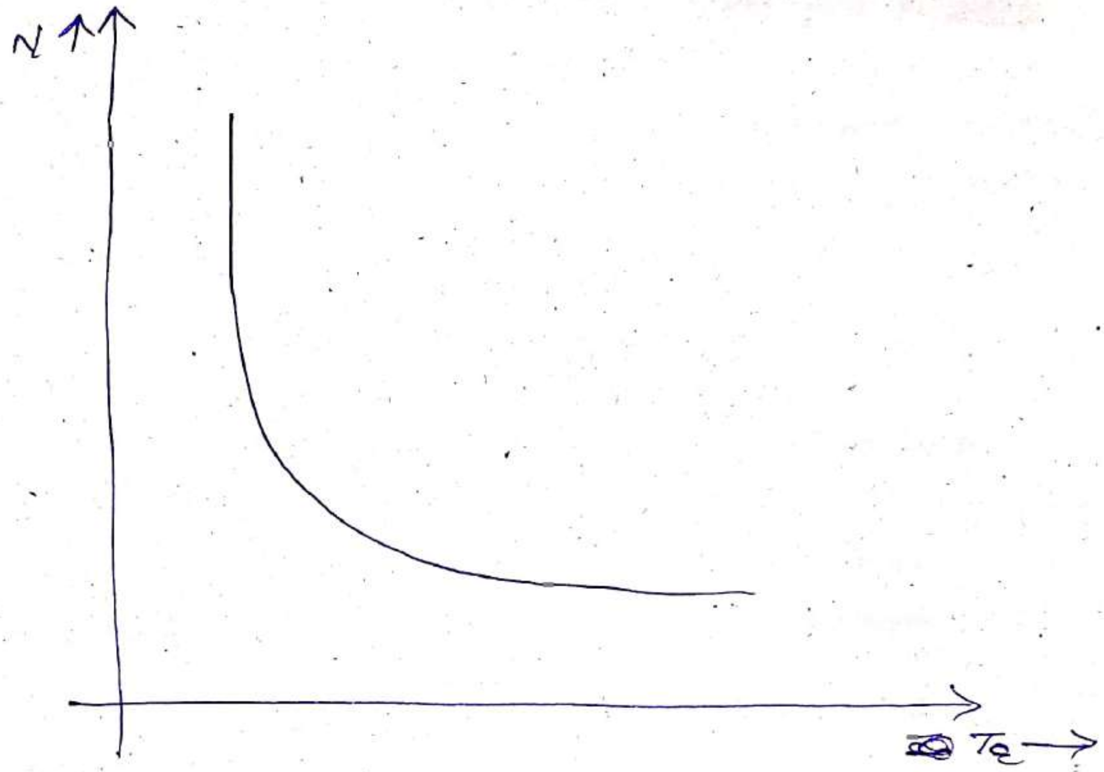
$N \sim T_e$

a. DC SHUNT MOTOR

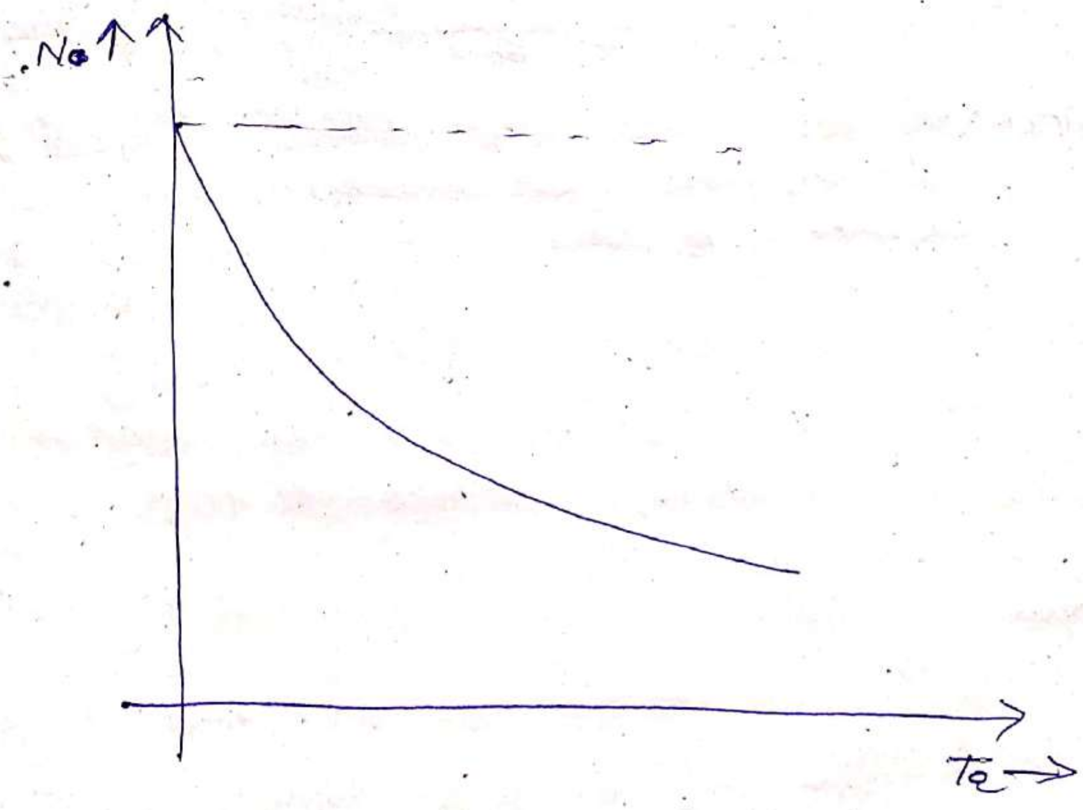
→ with increase torque speed decreases and vice versa



DC SERIES MOTOR

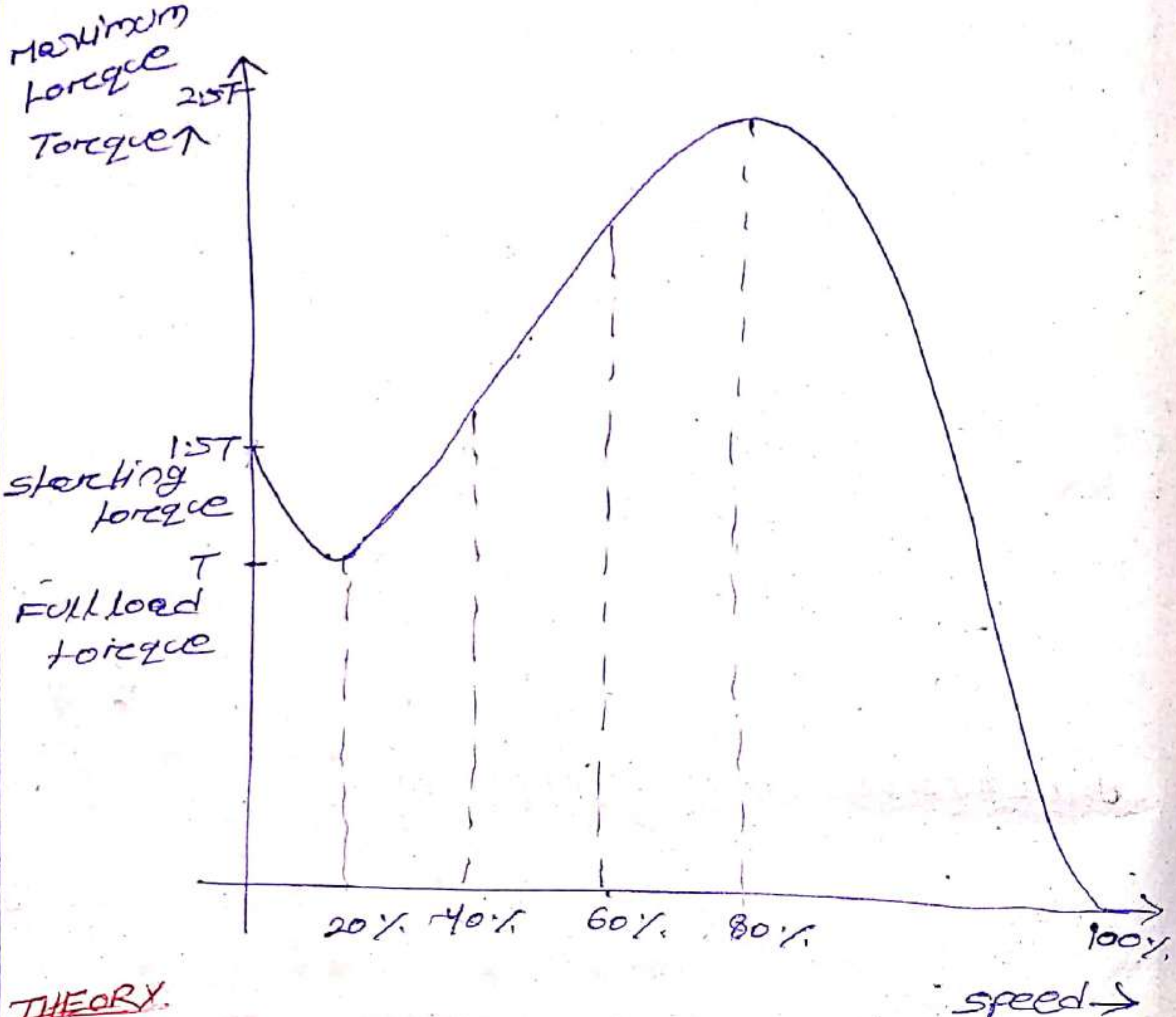


CUMULATIVE COMPOUND MOTOR



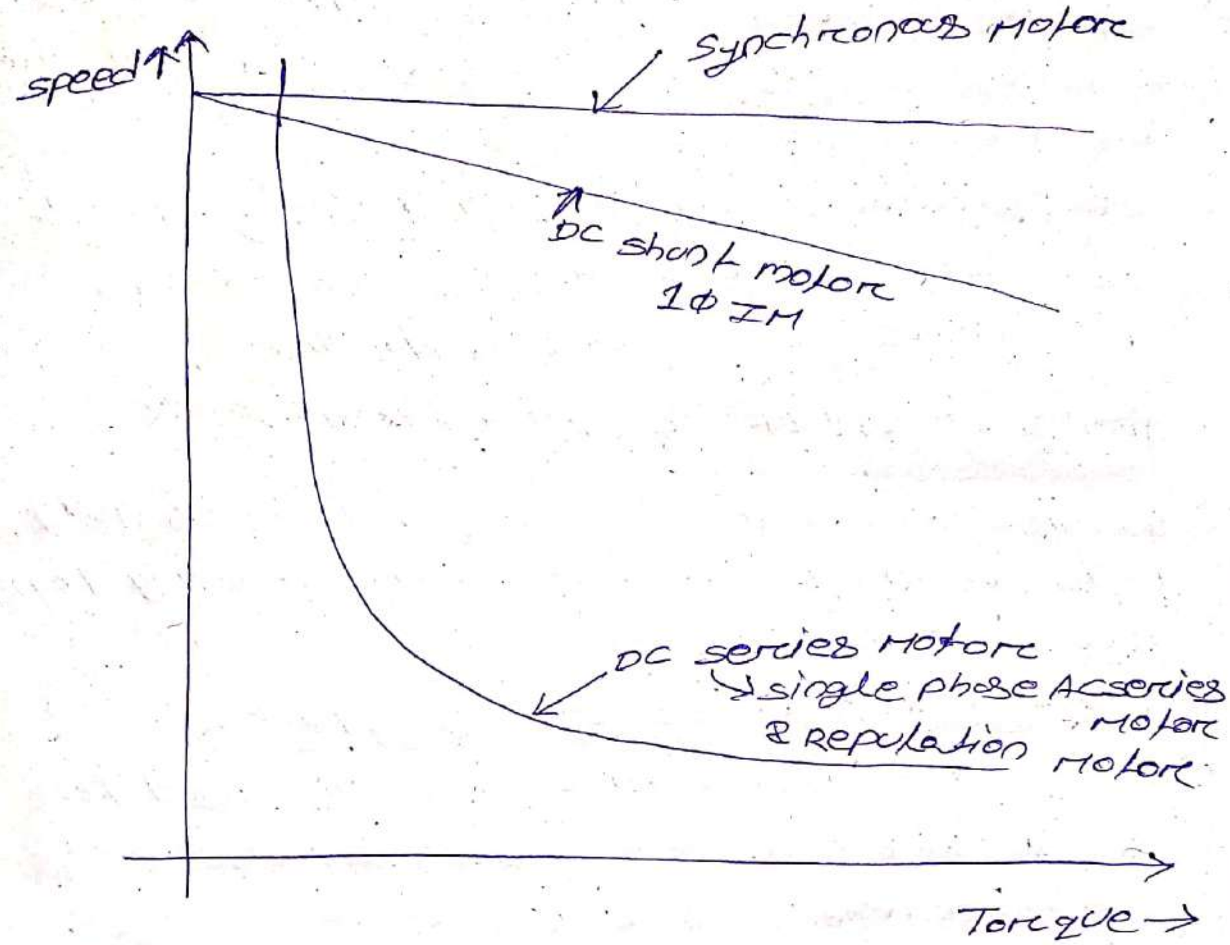
STARTING CHAR. OF 3Φ I.M

Torque ~ speed chart



THEORY.

RUNNING CHAR. OF AC MOTORS



APPLICATION OF DC MOTOR

SHUNT MOTOR

- It is approximately a constant speed motor.
- uses: Lathes, drills, sharpers, fans, lifts, centrifugal pumps, wiper, spinning & weaving M/Cs.

SERIES MOTOR

- variable speed motor i.e speed as low at high torque and vice versa.
- It is used when large starting torque as required
- use: Electric traction, cranes, vaccume cleaner, hair drier, Air compressor, sewing Machines

COMPOUND MOTOR

→ cumulative compound motor are used where a fairly constant speed is required with irregular loads.

→ uses: presses, reciprocating M/C, Elevators, Hoist, Rolling mills, compressors, conveyors, stamping machine.

APPLICATION OF 3Φ INDUCTION MOTOR

→ Electric train engine, printing machines, Rolling mills, chimneys at power plant, cooling fans used to cool large machines

APPLICATION OF SYNCHRONOUS MOTOR

synchronous motor are basically used for

i. power factor correction

ii. voltage regulation

iii. constant torque & constant speed

→ uses ⇒ Reciprocating pumps, compressor, rolling mills, centrifugal pumps, rubber & paper mills.

APPLICATION OF 1Φ INDUCTION MOTOR

uses: fans, washing machines, ~~ott~~ small machine tool, compressor, vacuum cleaner

APPLICATION OF AC SERIES MOTOR/UNIVERSAL MOTOR

→ uses: high speed vacuum cleaner, sewing M/C, electric shavers, drills, machine tools.

APPLICATION OF REPULSION MOTOR

→ Textile industry, air compressor, printing press, pumps & fans, High speed lifts, Hoists, petrol pumps, Mining tools, Air pumps, M/c tool etc.

CHAPTER-6

ELECTRIC TRACTION

→ Electric traction means a locomotion in which the driving force is obtained from electric motors.

→ EX:- Electric trains, electric vehicles, trolley buses, tram cars, disel electric vehicles, gas turbine electric vehicles.

ADVANTAGES OF ELECTRIC ~~VEH~~ TRACTIONS

i. cheapness:- It is the cheapest method of all other method of traction.

ii. Accleration & Breaking:- These are smooth and rapid.

iii. cleanliness:- It is free ~~fto~~ from smoke and fuels gases and hence clean method.

iv. Maintenance cost:-
Maintenance and repairing cost of electric traction is about 50% than that of seam traction system.

v. STARTING TIME
It can be started without any loss of time where as steam traction requires minimum 2hours before putting into operation.

vi. HIGH STARTING TORQUE
Electric traction system uses DC or AC series motor which has a high starting torque which makes accleration rate very high.

vii. BRAKING
In electric traction regenerative breaking is used which feeds back 40% of the energy.

viii. SAVING OF HIGH GRADE COAL
saving of high grade coal will happen because electrical energy required for running electric locomotive is taken either form hydro power station or thermal power station. which is run from low grade coals.

IX. It has good passenger carrying capacity at higher speed as compaire to steam locomotive.

X. Fan's and light's in electric trains can be connected directly to the supply lines connects and there is no need for providing extra generators and batterys.

DISADVANTAGES

→ Higher initial expenditure is involved in electric traction.

→ Failure of supply is a problem

→ Electrically operated vehicles have to move only on electrified network.

→ For electrical breaking and control adding equipment is required.

DIFFERENT SYSTEM OF TRACTION

→ The various systems of traction for rail road operation commonly used are:-

1. Direct steam Engine
2. Direct Internal combustion (IC) engine.
3. IC engine electric drive
4. Battery electric drive
5. Electric drive.

1. DIRECT STEAM ENGINE

In this type of drive the reciprocating steam engine is used for getting the necessary power because of it inherent simplicity and easy speed control.

→ The locomotive or train unit it self-contained therefore it is not fixed to any route.

ADVANTAGES

→ Initial cost is low as compair to electric drives

→ It has simple controlled.

DISADVANTAGES

- very low efficiency i.e 6-8 %
- Maintenance cost is high
- Limitted overload capacity.

2. DIRECT IC ENGINE TRACTION

- The char. of IC engine that it produces almost constant toreque at all speed..
- To increase the starting toreque and also fore speed control a geare box has to be provided.
- such arrengement is only applied to small trolleys where petrol engine is used.
- Effeciency is about 25%.

ADVANTAGES

- Initial cost is very low
- speed control and breaking system is very simple.

DISADVANTAGES

- speed control is only possible through a geare box
- Running and maintenance cost is high.
- overload capacity is limitted.

3. IC ENGINE ELECTRIC DRIVE

- In this system the geare box is eliminated. Here a diesel engine drives a DC generator coupled to it at a constant speed.
- The DC generatore supplies power to ~~drive are becoming widely used~~ electric motors fitted with the wheels.

ADVANTAGES

- No modification of exiting track is required.
- Low capital cost
- Greater rate of accleration at starting.
- overal efficiency is about 25%.

DISADVANTAGES

→ Maintenance and operating cost is high.
→ over load capacity is limitted.
→ Life of diesel engine is compairatively short etc.

4. BATTERY ELECTRIC DRIVES

→ Here the locomotive carries the secondary batteries which supplied power to DC motor used for driving the vehicles.
→ capacity of battery being small is used for local delivery of goods.

ADVANTAGES

→ Low maintenance cost and absence of fumes

DISADVANTAGES

→ storage capacity of battery is limitted thats why there used in local purpose.

5. ELECTRIC DRIVE TRACTION

It is most widely used system of traction, Here the vehicles draws the electrical energy from distribution system fed is suitable point from substation.

ADVANTAGES

→ clean method
→ maintenance and repairing cost is less
→ can be put in to service immideatly.
→ can withstand high overload for short time.

DISADVANTAGES

→ High initial cost
→ only applicable in electrified area.
→ In case of power failure system will become stand steel.

SYSTEMS OF TRACK ELECTRIFICATION

Two types of vehicles are used for electric traction. The first type of vehicle receives power form a distribution network while the second type of vehicle generate there own power.

-> The first type of vehicle are used on AC or DC power from overheadlines.

1. DC SYSTEM

-> In this system electric motor used are DC series motors. for main line railways the operating voltage is 1500V to 3000V and for suburban railways and tram cars the operationg voltage 600V.

-> The motor receives power from overheed lines with the help of pantograph and the railway steel track in the return conductor.

-> The overheedlines is fed from various substations. The AC power is converted to DC power by the help of mercury arc rectifier or rotary converter.

2. AC SYSTEM

a. 3Φ AC SYSTEM

This system employes 3Φ slip ring I.M. speed control of this system is obtained by combination of pole changing and rotor resistance method.

-> Regenerative breaking is obtained immidiately as the speed exceeds N_s without any changing condition.

-> The voltage and frequency at which motor is to perate are 3600V and $16\frac{2}{3}$ Hz

b. 1Φ STANDARD FREQUENCY SYSTEM

→ This system as a single overhead wires supply at 25kV ; 50Hz . It T/F is mounted on locomotive

→ which stepdown the voltage which is furthere rectified and supplied to the traction motor.

→ The driving force is obtained from DC series motor.

→ All modern day traction work is done by this system.

c. 1Φ LOW FREQUENCY SYSTEM

→ single phase , 15kV , 16 $\frac{2}{3}$ Hz , system is used in countries like Germany , sweden and Australia.

→ A stepdown T/F is carried in the traction unit which step dwon the voltage to about 400V for the use of traction motore.

→ Each substation is supplied at a high voltage at standard freqency . the voltage is step down and frequency is converted by motor generatore set.

→ AC series motore employed for traction

→ Due to commutative difficulties at normal frequency on such motore a low freequency supply is essential.

d. 1Φ TO 3Φ SYSTEM (KONDO SYSTEM)

In this system 1Φ high voltage AC system is employed for distribution network.

→ The locomotive carry a phase converter which converts 1Φ to 3Φ.

→ The 3Φ supply is connected to 3Φ IM ~~forg etting~~ for getting the necessary driving force.

→ voltage for distribution network is 16kV and 50Hz.

CONTROL OF MOTORS

-> The starting current taken by a DC motor during starting period is limitted to safe value equal to normal rated current by the resistance of the starter.

-> There is a considerable loss of energy at the starting resistance

-> The back emf of the motor starts to build of from zero magnitude at instant of switching $E_b = 0$

so

supply voltage = IR drop in armature + voltage drop in starting resistance

-> At any other point during starting

supply voltage = Back emf + IR drop in armature + voltage drop in starting resistance

-> At full running condition the starting resistance are cut out so.

supply voltage = Back emf + IR drop in armature.

1. TAPPED FIELD CONTROL

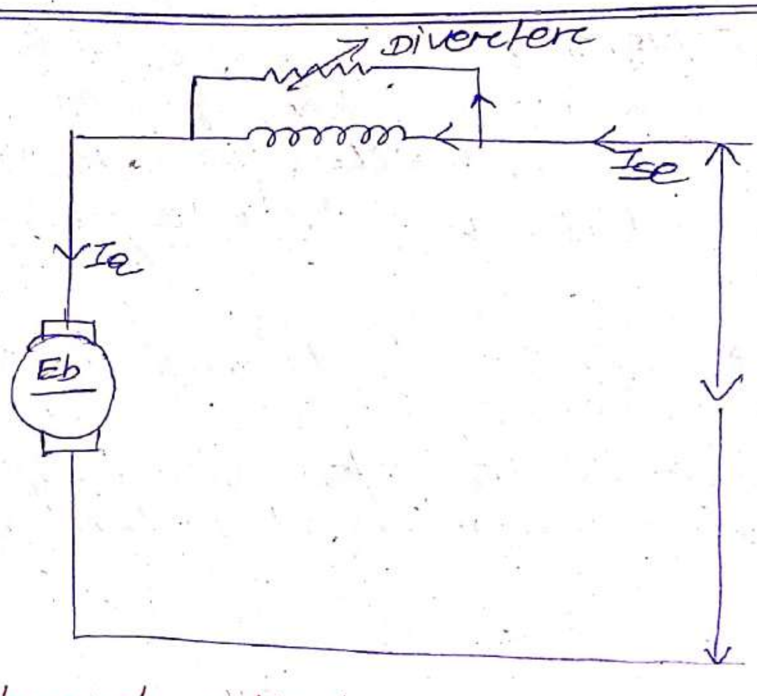
In case of DC series motor

$$N \propto \frac{1}{\phi} \quad \text{assuming } E_b = \text{constant}$$

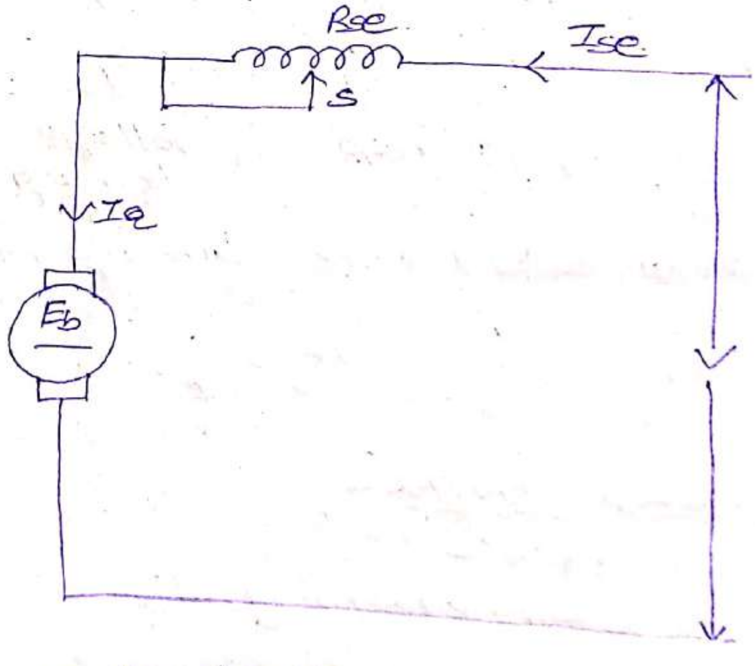
-> The flux can be varied either by connecting a variable resistance known as diverter in parallel with series field winding or by cutting some of the series field turns.

i Field diverter Method

-> The diverter will shunt some % of the current and the value of I_{se} decreases so flux (ϕ) decreases as flux is decreased so motor speed increases, by using this method motor speed above normal speed can be obtained.



ii Field Tapped Method



→ By doing the tapping no. of turns in the series field winding decreases so flux is reduced as flux is reduced speed is increased.

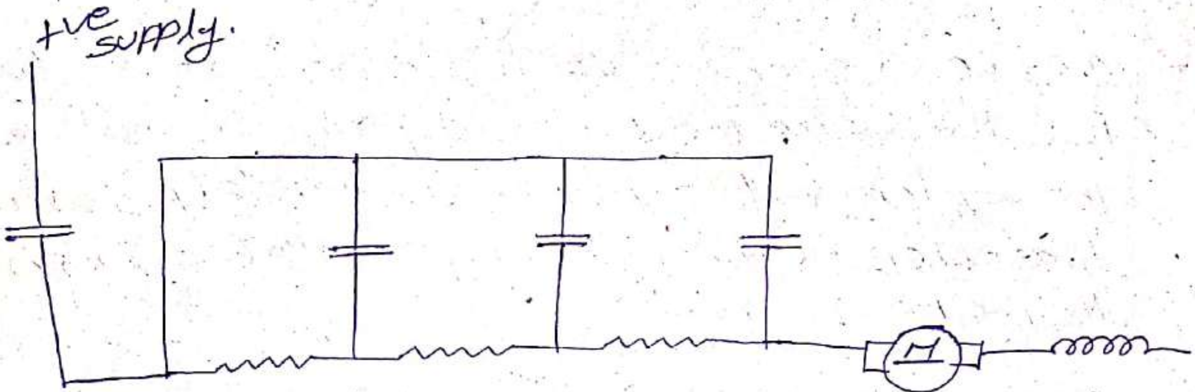
→ This method is used for increasing the speed of traction motor up to 10 to 15% when they have attened maximum possible speed by a series parallel controlled method.

2. RHEOSTARTING CONTROL METHOD

→ A series motor can be started by connecting an external resistance in series with the main ckt of the motor.

→ At starting $E_b = 0$, so full resistance connected in series with the motor.

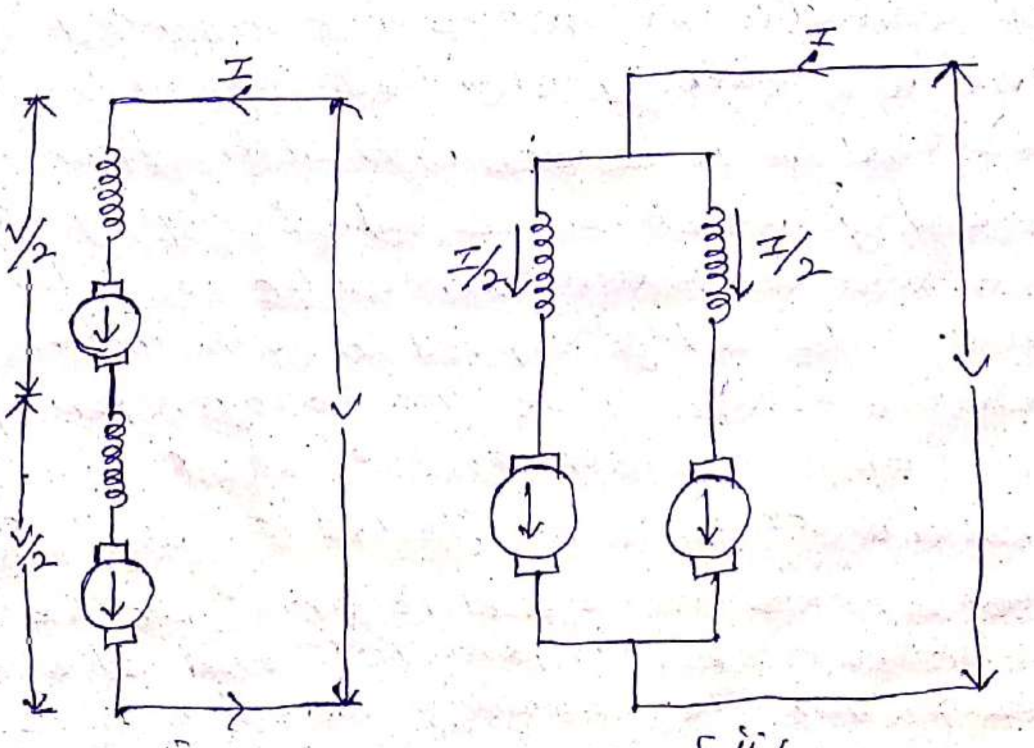
→ As the motor speed increased and E_b increases so resistances the gradually in steps in order to ~~maintain~~ mentain the current constant through out starting and ~~escillating~~ oscillating period.



(3) SERIES - PARALLEL CONTROL

→ Another method is used for the speed control of DC series motors is the series-parallel method. In this system which is widely use in traction system.

→ Two or more similar d.c series motor are mechanically coupled to the same load.



(i) (ii)

-> when the motor are connected in series (fig(i)) each motor armature will receive one-half the normal voltage, therefore the speed will be low.

-> when the motors are connected in parallel (fig(ii)), each motor armature receives the normal voltage and the speed is hig.

-> Thus we can obtain the two speed. Note that for the same load on the pair of motor, the system will be run approximately four time when meching are in parallel as when they are in series.

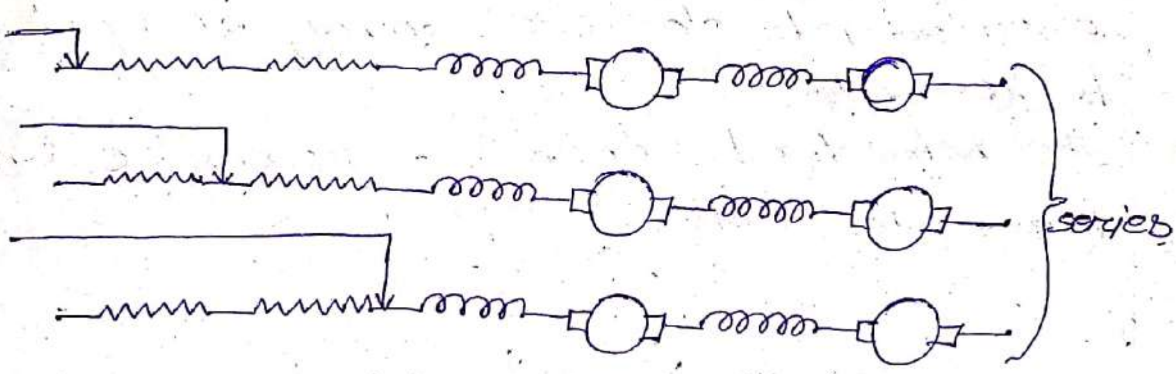
<u>series-parallel and Resistance control</u>

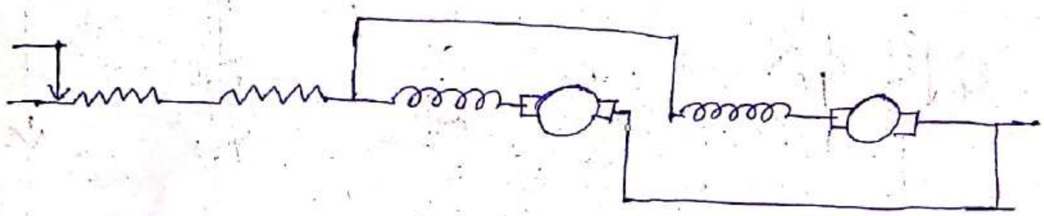
In electric traction series-parallel method is usually combined with resistance method of control.

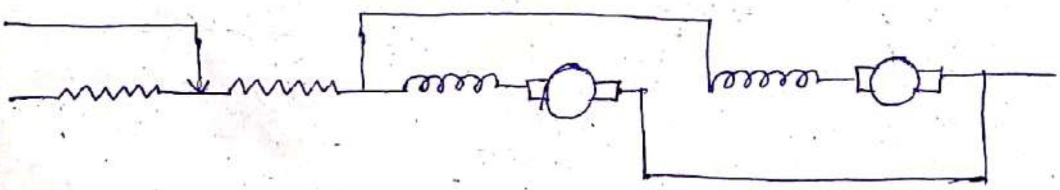
-> In simplest case two DC series motor are coupled mecahanically and drive the same vehicle.

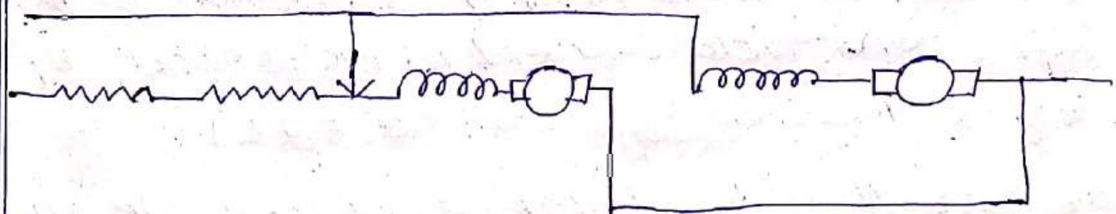
i At standstill, the motors are connected is series via a strating rheostat. The motore are started up in series with each other and starting resistance is cutout step by step to increase the speed. when all the resistance is cutout, the voltage applied to each motor is about one-half of the line voltage. The speed is then about one-half of what it would be if the full line voltage were applied to each motor.

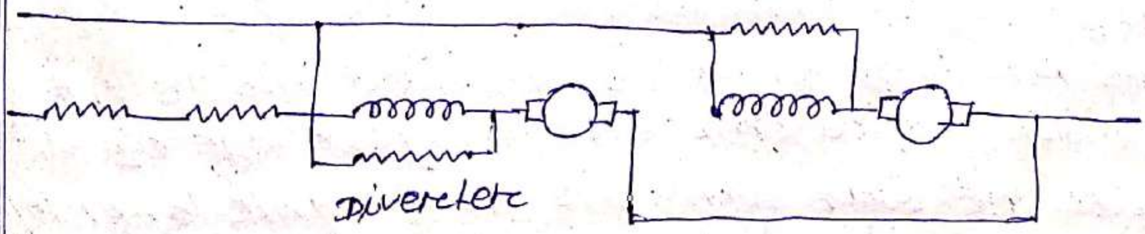
ii To increase the speed further, the two motor are connected in parallel and at the same time the starting resistance is connected in series with the combination. The starting resistance again cut out step by step until full speed is attained. The field control is introduced.









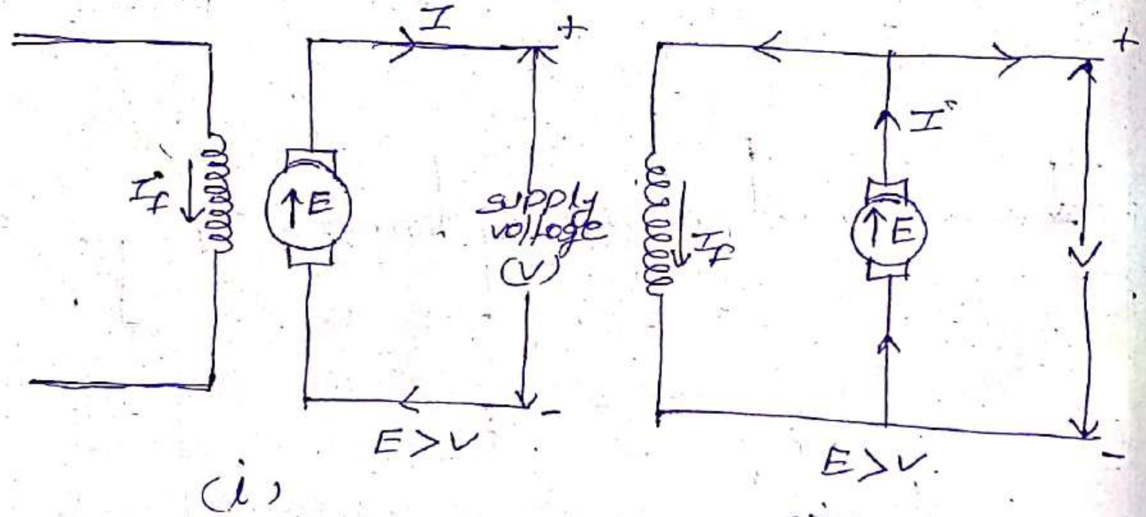


REGENERATIVE ~~CONTROL~~ BREAKING

In the regenarative breaking, the motore is run as a generatore.

→ As a result, the kinetic energy of the motor is converted into electrical energy and returned to the supply

→ The below fig two methods of regenative breaking for a shunt motore



(i) (ii)

(a) In one method, field winding is disconnected from the supply and field current is increased by exciting it form another source (Fig i).

→ As the result, induced emf E exceeds the supply voltage V and the machine feeds energy into the supply.

→ Thus breaking troque is provided into the speed at which induced emf and supply voltage equal.

→ As the M/C slows down, it is not possible to maintain induced emf at a highere vale. than the supply voltage. Therefore this method is possible only for limitted range of speed.

(b) In a second method, the field excitation does not change but the load causes the motor to run above the normal speed.

- As a result, the induced emf E becomes greater that the supply voltage V (see fig(ii)).
- The direction of armature current I, therefore reverse but the direction of shunt field current I_f remains unaltered.
- Hence the torque is reverse and the speed falls until E becomes less than V.

BREAKING WITH SINGE PHASE MOTORS

In this case both ~~re rebe~~ rheostatic and regenerative breaking are possible.

RHEOSTATIC BREAKING

- The motor are worked as separately excited generators supplying energy to resistance load.
- The field at energized at low voltage from suitable tapings on the train T/F.
- The kinetic energy of the rotor is dissipated as electrical energy in the load resistance.
- Also the field of the motor may be excited from one of the motor acting as a 'series generators.
- In this case DC will be generated in the rotore of the motoris and the kinetic energy of rotores will be dissipated as D.C power in the loading resistores.

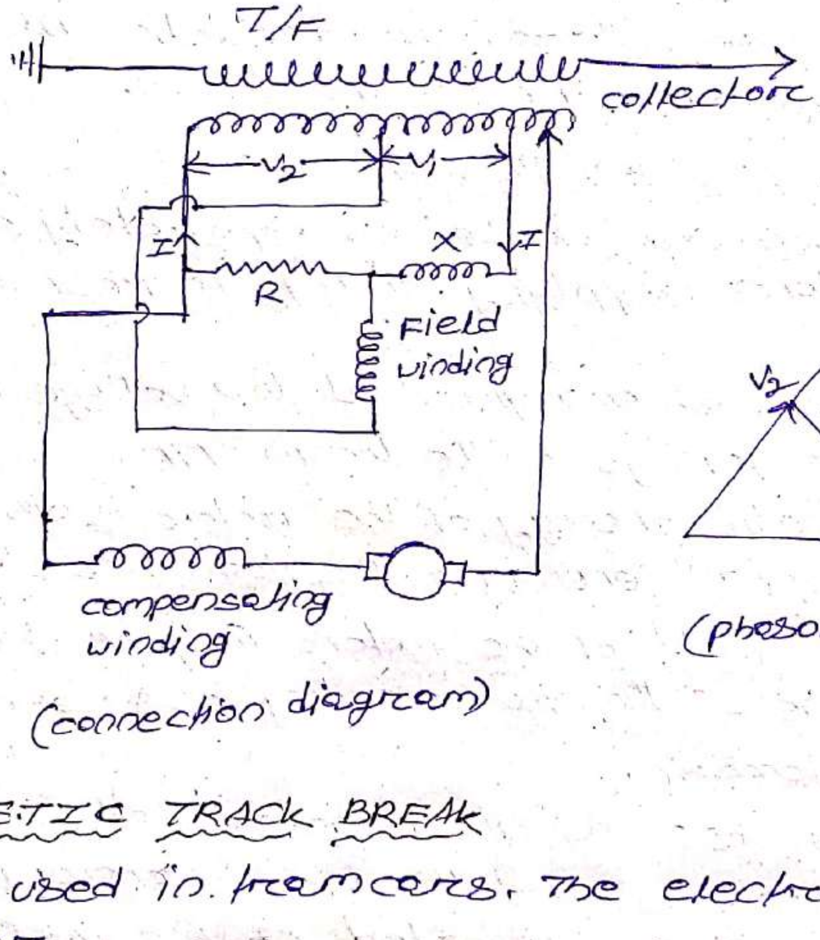
REGENERATIVE BREAKING

- The regenerated power should be at frequency of the main supply.
- The necessitates the energizing of the field winding from the main supply.

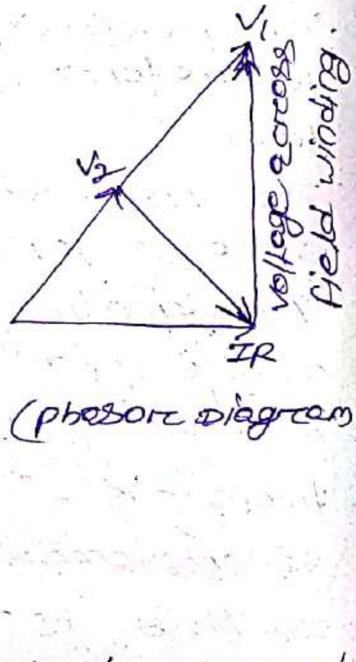
→ secondly, the regenerated current must be in phase opposition to the applied voltage and also the flux Φ so that the power may be feed back into the supply system

→ The voltage applied to the field winding must be 90° out of phase with respect to the supply voltage.

→ An arrangement to obtain these conditions is shown below.



(connection diagram)



(phasor diagram)

MAGNETIC TRACK BREAK

→ It is used in tramcars. The electromagnet bipolar.

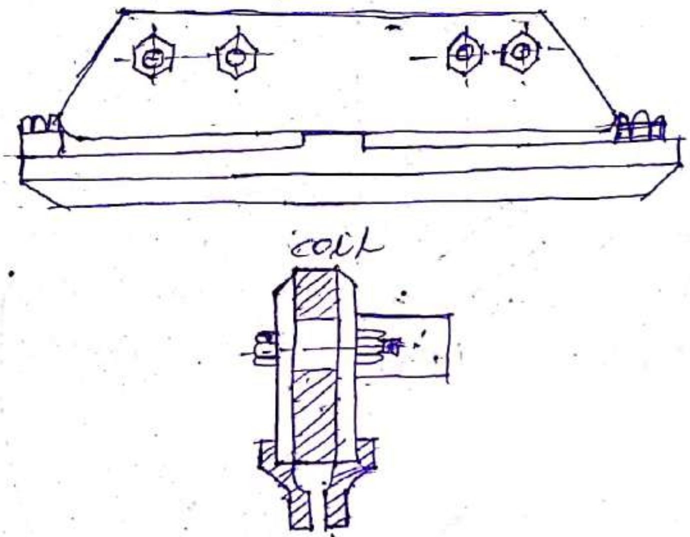
→ The body is made of cast steel and the pole faces are made of soft steel and can be renewed.

→ The exciting coil is enclosed in a water-tight case.

→ The magnetic flux is perpendicular to the pole faces and track. The force of attraction between the magnet and the track given by -

→ $F = \frac{B^2 a}{2 \times \pi \times 10^{-7}}$ N, where B is flux density in weber/m2 and 'a' is the area in the pole face in sq.m.

→ The drag that it can produce on the car is given by micro farad, where f is the coefficient of friction.



METADYNE SPEED CONTROL

→ This speed control system is based on constant current system.

→ In this system metadyne converter is used which takes power at constant voltage and variable voltage.

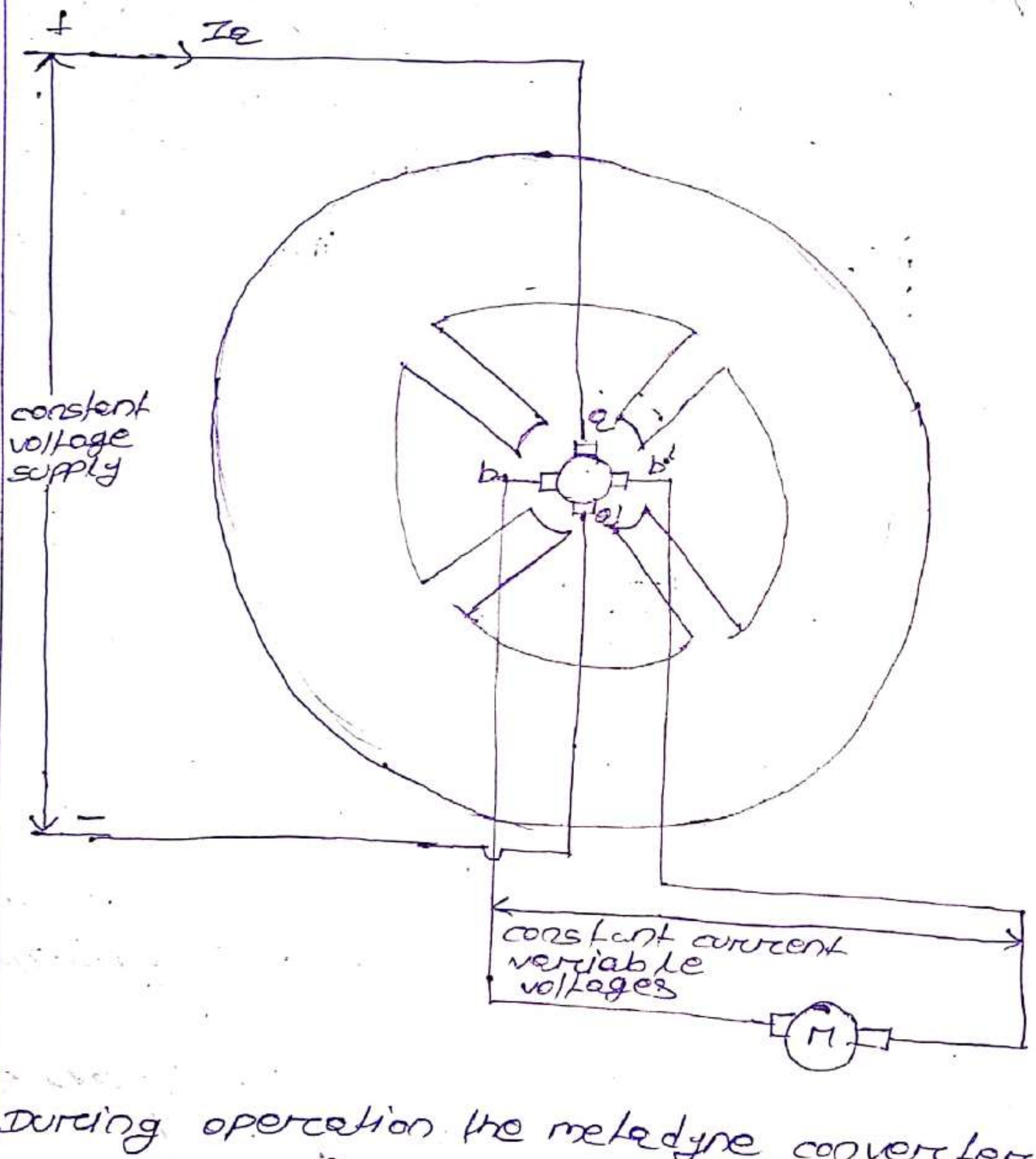
→ In series parallel control or resistance control systems there is waste of electrical energy in the starting resistance. and the Jerks are also experienced when the controller of the starter moves on notches.

→ In metadyne speed control since current through out the starting period remains constant, uniform tractive effort is developed.

→ This gives very smooth drive and high coefficient of adhesion.

→ The converter has two pole d.c. armature and four pole field magnet as shown in below fig :

→ There are two sets of brushes, one set connected to a constant voltage supply main and the other is disconnected to the load or traction motor.



→ During operation the metadyne converter draws current Ia from the mains.

→ The other set of brush will feed constant current at varying voltage to the traction motor

DC AND AC TRACTION MOTOR

→ DC traction motor are generally used for dc traction purposes, dc locomotives and drives.

→ The speed can be canged by variation of the field winding taps. By using the rheostat taps the resistance is varied and accordingly the speed will be varied.

→ Also for control in a DC drive, dc traction motors (series type) can be engaged. These traction motor may be operate in series or parallel

→ For the higher speeds requirement, the motors are operated in parallel and for lesser speed series connected motor are essential.

→ In case of parallel operation of two traction motors the dc supply voltage available will be constant (high) and as speed ∝ 'V' ⇒ speed increases.

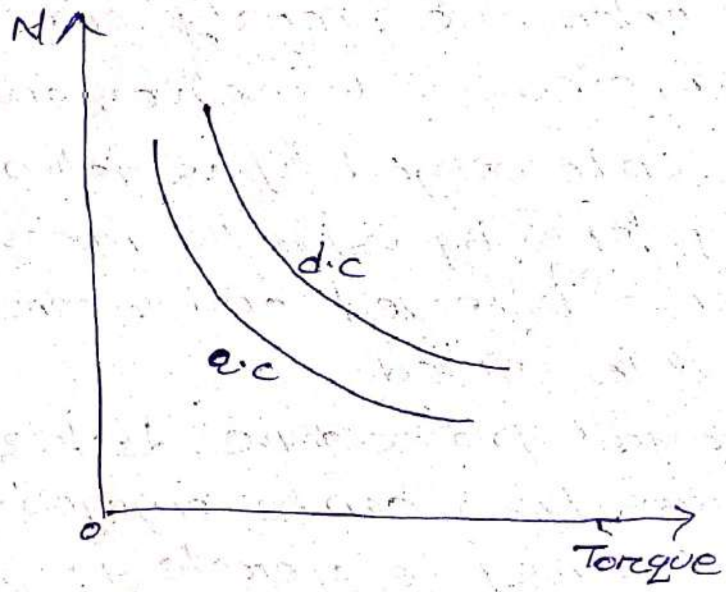
→ Also AC series traction motors may be operated in AC drive system i.e. in railway a.c traction motor are preferred.

→ The 1Φ compensated series motors have been built for tractions work upto sizes of several hundred H.P.

→ They have low PF at starting and therefore starting torque is low.

→ The A.C. series motor is not well suited to sub-urban services and stops are frequent.

→ The speed torque char. is similar to that of a DC series traction motor and is drawn below.



→ Also 3φ Induction motor can be used for the traction purpose but with lesser extent. It has been used in the kando system.

VEET

CHAPTER-1

(2 mark)

1. Define Electro-deposition.
2. Define Current efficiency.
3. Define energy efficiency.
4. State the factors governing electro-deposition.
5. Define Electro chemical equivalent.
6. Define throwing power.
7. Define Electro forming.

Long type

1. Explain the principle of electro-deposition with suitable diagram.
2. State and explain Faraday's law of electrolysis.
3. Explain briefly factors affecting better electrodeposition.

CHAPTER-2

2 mark

1. State Stephen's law.
2. Define Skin effect.
3. State some application of Dielectric heating.
4. State applications of Microwave heating.

Long type

1. State briefly the advantages of electric heating over conventional method of heating.
2. Explain the principle of resistance heating with suitable diagram.

3. Explain working principle of direct Arc furnace and indirect arc furnace with suitable diagram.

4. Explain working principle of vertical core type induction furnace and indirect core type induction furnace.

5. Explain briefly the principle of dielectric heating.

CHAPTER - 3

2 mark

1. Define electric welding.
2. Classify Electric welding.

Long type

1. Discuss briefly the principle of Arc welding.
2. Explain briefly different types of Arc welding.
3. Explain different types of resistance welding.

CHAPTER - 4

2 Mark

1. Define luminous flux.
2. Define luminous efficiency.
3. Define solid angle.
4. Define luminous intensity.
5. Define Candle power & lumen.
6. Define Illumination.
7. Define MSCP / MHCP / MHSCP.

8. Define Maintenance factor & Depreciation factor.

9. Define Utilisation factor.

Long type

1. State and explain Laws of illumination.
2. Explain polar curves.
3. Explain the construction and working principle of filament lamp.
4. Explain the construction and working principle of fluorescent lamp.
5. Explain construction and working principle of Sodium vapour lamp.
6. Explain construction and working of Mercury Vapour Lamp.

CHAPTER-5

2 Mark

1. Define group drive.
2. Define Individual drive.
3. Applications of different Motors.

Long type

1. State group drive vs. individual drive.
2. Explain methods of choice of electric drive.
3. Explain starting and running characteristics of DC Motor.

CHAPTER - 6

2 Mark

1. Define Electric traction
2. Define Electric braking.

Long type

1. Explain different system of traction.
2. Explain different methods of speed control of DC Motor.
3. Explain different methods of braking.