Part - C

Answer the following questions in briefly

1. What is called Atom?
2. What preventive precautions should be taken to avoid electric shock?
3. What is Electricity?
4. What is current?
5. What are the different method of artificial repiration?
6. What are the methods used for production of Electricity?

Part - D

Answer the following questions in one page level

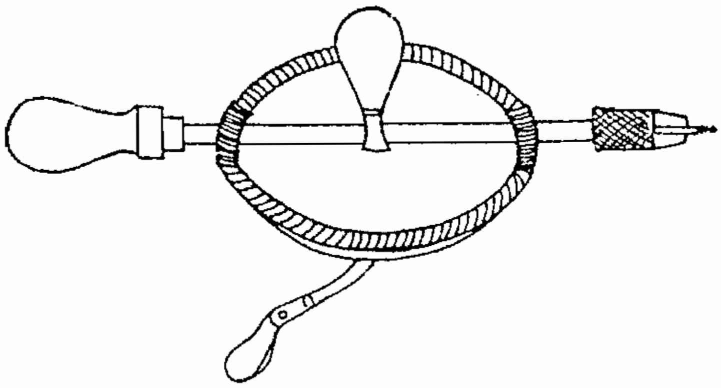
1. Explain the structure of Atom?
2. Explain the methods of prevent electric shock?
3. Explain the different types of First Aid?

Part - E

Answer the following questions in two page level

1. Explain the power generating methods?
2. Explain the Electrical safety and precautions?

13. HAND DRILLING MACHINE



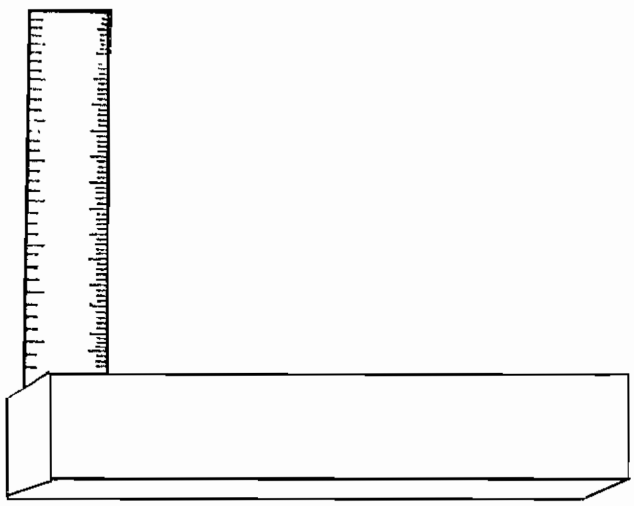
It is used to make holes in wooden materials. In one end of this machine a chuck is available to fix required drilling bit. Fixing it i wood by keeping the handle tightly, holes are made by rotating the cli

14. FILES

It is used to correct the size and smooth the upper part c metals. It is named according to the size and the rough surface fo smoothing other surface.

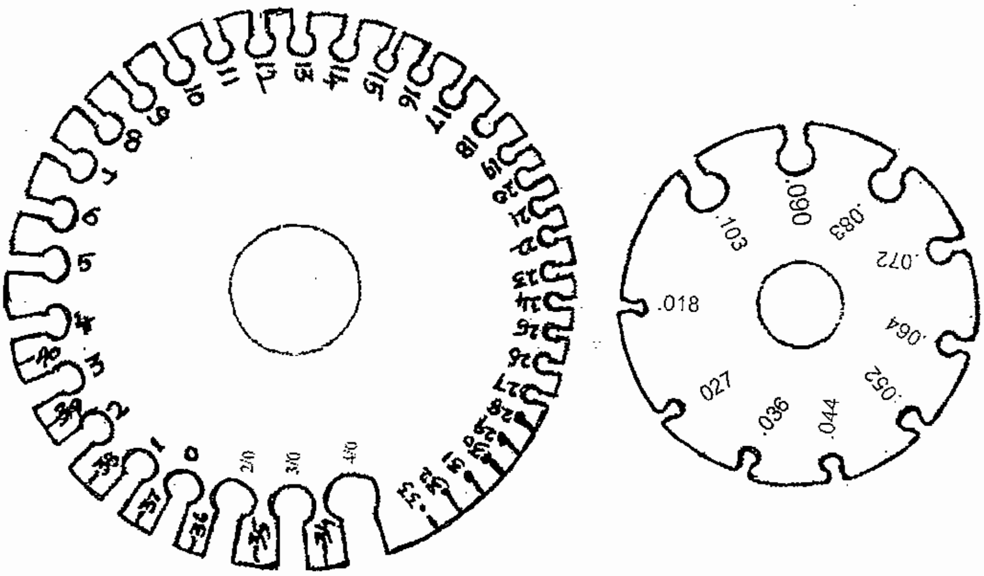
TRY SQUARE

It is used for measuring angles of 90: (Right angle) Measure-ments in mile metre are marked in its scale. It is used to measure 90 right angle accurately.



WIRE GAUGE PLATE

It is of round shape. It is used to measure the width of wires. Its unit is gauge. The wire is put into the hole in the centre of the Gauge to measure its width. Wires are available in gauge of 8 SWG, 12 SWG, 18 SWG.



2.3 TYPE OF SWITCH

S.P.T Switch: This is a mechanical device used for opening or closing an electrical circuit. Single pole switch is used for closing (or) opening one phase only most of the switches are turmbler type but, now a days flush type switches are used.

2.3.1 Intermediate switch : To control a light from more than two different places, the intermediate switch is used for example a long hall, corriders and passage ways with many doors etc.

2.3.2. Knife switch: Knife switch is made of Copper and is generally used in laboratories for switch boards. It has a long piece ofl copper strip hinged in one end and which can go into a copper socket at the other end. It has got an insulated handle and two terminals. Below the main some times there is additional small strip held by means of springs. The small strips makes contact to permits any number of control points.

2.3.3 Main Switch: Main switch is the one which controls the electrical supply for whole house (or) factory. These are also called as Iron clad switches. There are different types, Two pole and Three pole in the Two pole switch, their will be two fuse units, the neutrol one will have a link and the phase 1. will have the rated fuse wire. There is also an earth terminal. The Iron clad switch has a metalic cover which can be screwed out for changing the blown out fuse only. After putting of the switch. From the main switch leads are taken to the distribution box.

3.1.5 Potential Difference

It is represented by, the potential difference between any two points in the electrical circuit. Shortly it is called PD and the Unit is Volt.

3.1.6. Electric Power

Power is defined as the product of voltage and current. Unit of power is watts. The energy absorbed by an appliance in one hour is called the energy consummed by the appliance. It's unit is watt and denoted by the letter "P."

P	=	V x I watts
Electric work Q	=	P x t watt hour
one killo watt hour	=	1 Unit

3.1.7. Law of Resistance

The resistance of a conductor in a circuit depends upon the following states.

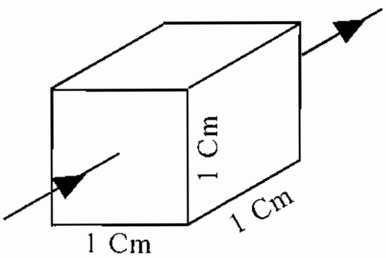
- It depends upon the material.
- Directly proportional to the length of the conductor.
- Inversely proportional to the area of the cross-section of the conductor.
- I t also depends upon the temperature of the conductor.

Resistance calculation

$$\text{Resistance} = \frac{\text{Specific resistance x length}}{\text{Area of the cross-section}}$$

$R = \rho l / a$

R - resistance - ohms



ρ - Specific resistance - Ohm meter

L - Length of the conductor - meter

A - Area of the cross-section of a conductor – Sq.m

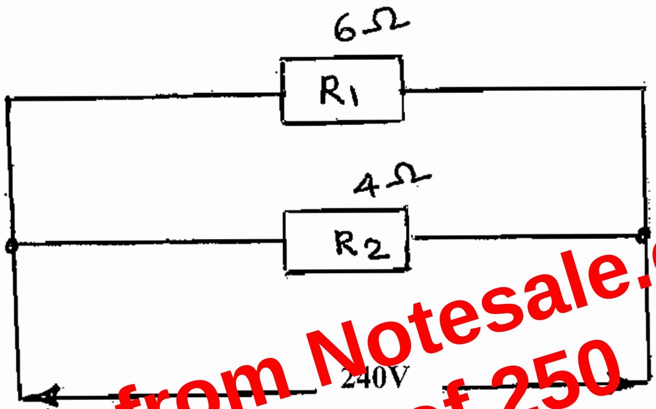
IMPORTANT RULES OF PARALLEL CIRCUIT

1. In the parallel circuit current flows though two or more paths at a junction. That is, it gets divided.
2. $I = I_1 + I_2 + I_3$ ....
3. The voltage drop is same in all resistors
4. If there are 3 restistors (R_1, R_2, R_3) in the circuit $R = \dfrac{R_1R_2R_3}{R_2R_3 + R_1R_3 + R_1R_2}$
5. If there is a fault in one resistor the other wto resistors will work. The current will be divided into two parts and will flow through the two resistors.

Example

6Ω and 4Ω resistors are connected in parallel through 240v supply. Find out the total resistance and current flows in it.

Solution



Fig

$R_1 = 6\Omega$ $R_2 = 4\Omega$ $V = 240V$

$R = ?$

In parallel circuit

$$R = \frac{R_1R_2}{R_1+R_2} = \frac{6 \times 4}{6+4} = \frac{24}{10}$$

$$R = 2.4\ \Omega$$

According to ohm's law

$$I = \frac{V}{R} = \frac{240}{2.4} = 100A$$

$$I = 100\ Amp$$

Example

Three resistors 10Ω, 5Ω and 2Ω are connected in parallel.

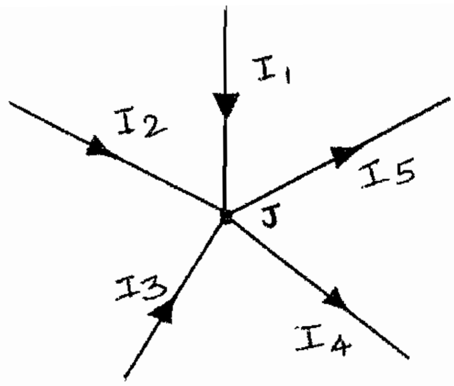


Fig. 3.9 (a)

In the fig. above, J a junction (or node) formed by five conductors. The current in these conductors are I_1, I_2, I_3, I_4, and I_5.

Some of these currents are flowing towards J and others away from it.

According to Kirchoff's Law

$I_1 + I_2 + I_3 \quad = I_4 + I_5$

(Flowing towards J) = (Flowing away from J) =

Otherwise

$I_1 + I_2 + I_3 - I_4 - I_5 = 0$. This is known as KCL equation.

Voltage Law

At any closed circuit the Potential Drop (IR) at each Resistance is equal to the total voltage given to the circuit.

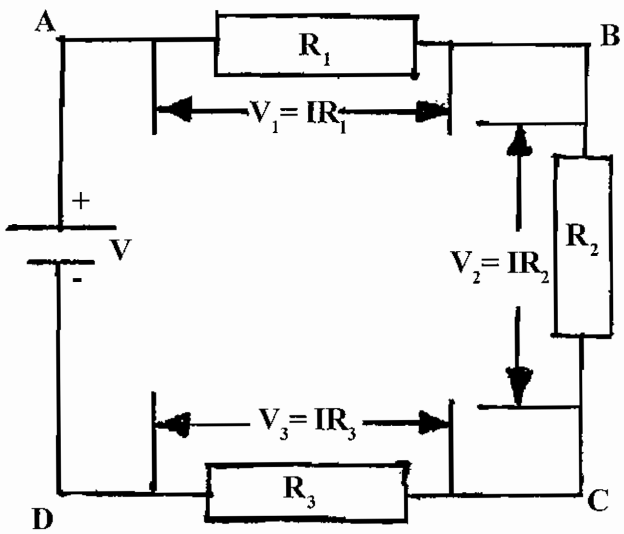


Fig. 3.9 (b)

In a closed circuit, the sum of the potential drop is equal to the sum of the potential rises. This is called Kirchoff's Voltage Law.

$V = IR_1 + IR_2 + IR_3$

Example

In the circuit of Fig, find using Kirchoff's laws, the current in the various elements.

Solution

According to Kirchoff's first law mark the direction of current flow. According to Second law, Write down the KVL equation in the closed circuits.

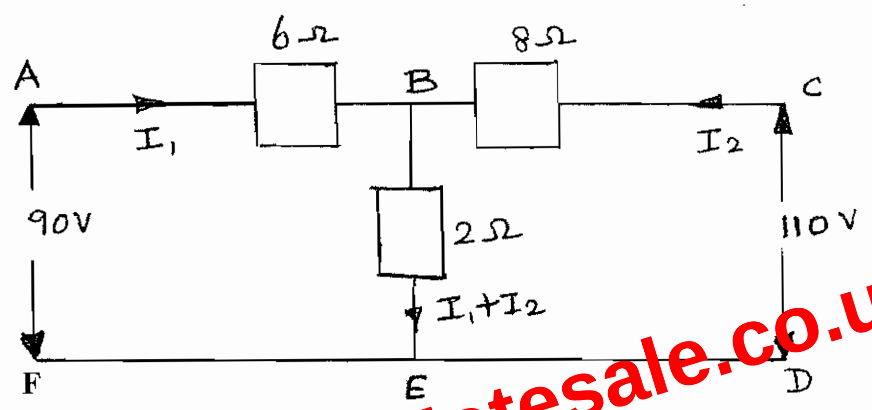


Fig.

1. ABEFA forms a closed circuit

$6I_1 + 2(I_1 + I_2) = 90$

$8I_1 + 2I_2 = 90$

2. CBEDC forms another closed circuit.

$8I_2 + 2 (I_1 + I_2) = 110$

$2I_1 + 10I_2 = 110$

$8I_2 + 2 I_2 = 90 \ (1)$

$2I_2 + 10 I_2 = 110 \ (2)$

To solve, equation (2) is multiplied and subtracted from (1) by 4.

$8I_1 + 2I_2 = 90 \quad (3)$

$(2) \times 4 \ \_ \ 8I_1 \pm 40I_2 = \ \_440 \quad (2)$

$-38I_2 = -350$

$38I_2 = 350$

Now, the supply is given to the capacitor, the electrode connected in the +ve terminal gets positive charge (+) and the electrode connected in the –ve gets negative charge(-). During this, capacitor gets charging. i.e., The amount of charge between the plates depends upon the dielectric material and also the distance between the electrodes. After few seconds the current flow stops. Now the capacitor voltage is equal to the supply voltage. In this way the power can be stored in a capacitor. This stored power can be used again when needed.

3.12. POWER OF CAPACITOR

Power of the capacitor can be depends upon the construction ie.,

- directly proportional to the area of the electrodes.
- Inversely proportional to the distance between the two electrodes.
- Depends upon the di-electric strength of the insulating media.

3.14 CAPACITANCE

The capacitance of a capacitor is defined as the ratio between the changing given to the capacitor. This is denoted by the letter C and the unit is Farad.

$$\text{Capacitance (C)} = \frac{\text{Charge (Q)}}{\text{Voltage (V)}}$$

$$\text{Therefore } C = \frac{Q}{V} \text{ Farad}$$

Hence C — Capacitance - Farad

Q — Charge given to the capacitor - Coulomb

V — Potential difference between the plates – Volt

If the dielectric medium between the two plates is stronger, then the capacitor can have high charging capacity.

Lower value of capacitance is called as micro farad & Picco farad.

3.14. ONE FARAD

When one volt supply is given to the capacitor, it will get 1 coulomb charge then it is called as 1 Farad.

3.15 TYPES OF CAPACITORS

Capacitors can be classified depending upon their construction and also the material used for making the capacitor. For this, two types are classified as (i) Fixed Capacitor (ii) Variable Capacitor.

3.16. WORK, POWER, EFFICIENCY AND ENERGY

Work

If a force of F moves a body through a distance S in its direction of application is called work. The unit of work is Newton meter. If 1 Newton force displaces a body through a distance of 1 meter then the work done is 1 Nm (Newton-meter)

The potential difference applied across the coil causes to flow through it. This implies that there is an electrical work done. Unit of work done in Joule. In Electric circuit if 1 volt electric potential causes one coulomb of electric charge to pass through a circuit then the electric work done is equal to 1 Joule.

1 Jouel = Volt x Coulomb

Coulomb = Ampere x Time

J = V x I x t

Power

It is the rate of doing work. Its units is Watt (W)

$$\text{Power} = \frac{\text{Work done}}{\text{Time}} \quad \frac{\text{Joules}}{\text{Time}}$$

$$P = \frac{J}{t}$$

$$P = \frac{V \times I \times t}{t}$$

P = VI watts

According to Ohm's law

$V = IR$

$P = I.R.I. = I^2R$ watt

$P = VI$ (or) $P = I^2R$

$$I = \frac{V}{R}$$

$P = VI$

$$P = \frac{VV}{R} = \frac{V^2}{R} \text{ watt}$$

P = Power in Watt

V = Voltage in Volt

I = Current in Ampere

Example 4

Three resistors 4Ω, 6Ω and 8Ω are connected in parallel across 36 V DC supply find the total resistance and the current through each resistance.

$$\frac{1}{R_t} = \frac{1}{R_1} = \frac{1}{R_2} = \frac{1}{R_3}$$

$$= \frac{1}{4} + \frac{1}{6} + \frac{1}{8}$$

$$\frac{1}{R_t} = \frac{13}{24}$$

$$\therefore R_t = \frac{24}{13} = 1.846\Omega$$

$$I_1 = \frac{V}{R_1} = \frac{36}{4} = 9A$$

$$I_2 = \frac{V}{R_2} = \frac{36}{6} = 6A$$

$$I_3 = \frac{V}{R_3} = \frac{36}{8} = 4.5A$$

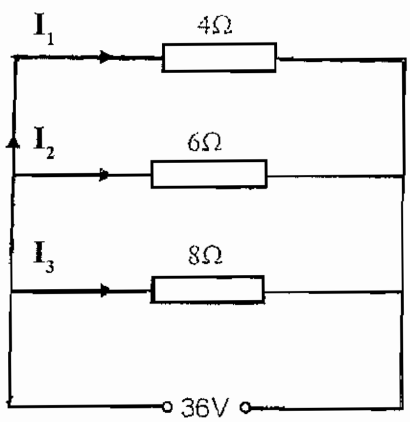


Fig.

Example 5

Three resistor 2, 4 and 12 ohms are connected in parallel across a 12V battery. Find the current through each resistors and the battery. Also find the power dissipated in each resistor.

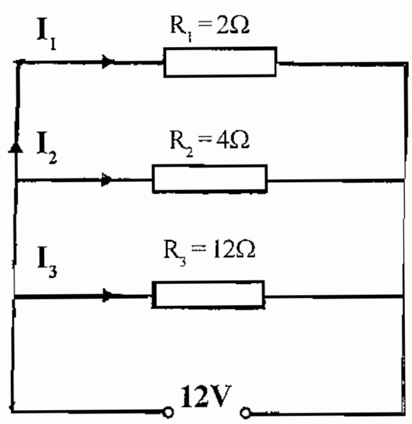


Fig.

4.6.6. Magneto – Motive Force

The amount of flux density set up in the core is dependent upon five factors - the current, number of turns, material of the magnetic core, length of core and the cross-sectional area of the core. More current and the more turns of wire we use, the greater will be the magnetising effect. We call this product of the turns and current the magneto motive force (mmf), similar to the electro motive force (emf).

MMF = NI ampere - turns

where mmf - is the magnetomotive force in ampere turns

N - is the number of turns wrapped on the core

I - is the current in the coil, in amperes, A.

4.6.7. Magnetic Reluctance

In the magnetic circuit there is something analogous to electrical resistance, and is called reluctance, (symbol S). The total flux is inversely proportional to the reluctance and so if we denote mmf by ampere turns. we can write

$\phi = \frac{NI}{S}$ where ϕ is flux, and relutance $S = \frac{\ell}{\mu_o \mu_r a}$

where S - reluctance

I - length of the magnetic path in metres

μ_o - permeability of free space

μ_r - relative permeability

a - cross-sectional area of the magnetic path in sq.mm.

Its unit of reluctance is ampere turns/Wb.

4.7. Comparison between magnetic and Electic circuit

S.No.	Electric Circuit	Magnetic Circuit
1.	Electro motive force in volt (unit)	Magnetic motive force in ampere turns (unit)
2.	Current in ampere (I)	Flux in webers (ϕ)
3.	Resistance $R = \rho l / a$	Reluctance in At/wb $S = 1/au$
4.	Conductivity = $\frac{1}{\text{Resistivity}}$	Permability = $\frac{1}{\text{Reluctivity}}$
5.	Conductance = $\frac{1}{\text{Resistance}}$	Pemeance = $\frac{1}{\text{Reluctance}}$

Energy stored in a magnetic field

For establishing a magnetic field, energy must be spent, though to energy is required to maintain it. Take the example of the exciting coils of an electromagnet. The energy supplied to it is spent in two ways, (1) Part of it goes to meet I^2R loss and is lost once for all (ii) part of it goes to create flux and is stored in the magnetic field as potential energy, and is similar to the potential energy of a raised weight, when a mass M is raised through a height of H, the potential energy stored in it is mgh. Work is done in raising this mass, but once raised to a certain height. No further expenditure of energy is required to maintain it at that position. This mechanical potential energy can be recovered so can be electric energy stored in a magnetic field.

When current through an inductive coil is gradually changed from Zero to a maximu, value then every change of its is opposed by the self-induced emf. produced due to this change. Energy is needed to over come this opposition. This energy is stored in the magnetic field of the coil and is, later on, recovered when those field collapse.

Questions

Part A

I. Choose the Correct Answer

1) Ferro magnetic substance are

a) Good insulator
b) good conductor
c) the same as that of diamagnetic material
d) Strongly attracted by a magnet.

2) Unit of flux is

a) Ampere
b) Webber
c) Watts
d) None of these

3) Para magnetic substance are:

a) Weakly attracted by a magnet
b) The same as that of dia magnetic meterial.
c) Weakly repelled by a magnet
d) Produced by heating iron above the curic point.

4) The mmf can be compared with

a) the force of attraction between two magnetic force
b) the force of Repulsion between two magnetic force
c) the force of earth magnetic field.
d) the electro magnetic force.

5) The reluctance can be compared with

a) Conductance
b) Inductance
c) Resistance
d) capacitance

6) The magnetic flux can be compared with

a) Electro static flux
b) Electric current
c) Magnetic current
d) Magneto motive force.

7) A solenoid is defined as an electromagnet,

a) having only one turn
b) having more axial length than diameter
c) Less axial length than diameter
d) having more resistance.

5.4. ELECTRICAL ENERGY IS CONVERTED INTO ELECTROMAGNET ENERGY.

Ex : Electrical energy is converted into Magnetic circuit breaker, telegraphic machine.

5.4.1. Magnetic Circuit Breaker

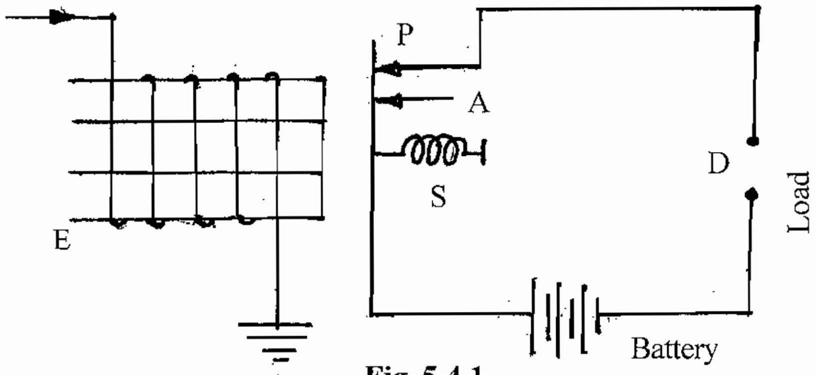


Fig. 5.4.1.

Electric supply is given to the apparatus D from the battery. The conductor A always touches terminal P with the help of spring. The electromagnet E attracts conductor A, if the current flow is beyond specified limit. The apparatus isolated from electric supply due to terminal P. If current through electromagnet is reduced, attraction also reduces. The conductor A retain its place and operate the apparatus.

5.4.2. TELEGRAPHIC MACHINE

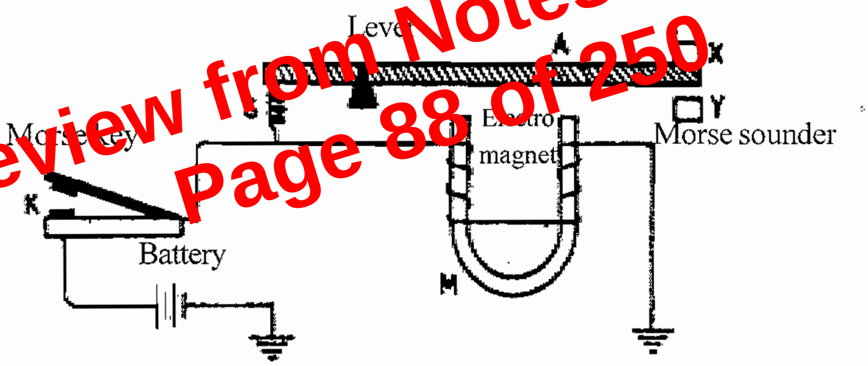


Fig. 5.4.2.

The American scientist Morse found Telegraphic machine. Which is used to send the message from one place to another. The machine part sends the message is 'Morse Key' and the machine part receives the message is 'Morse Sounder'.

The battery circuit closes through morse key K and electromagnet M. The lever is placed on the electromagnet. The lever touches nail Y due to spring, the electromagnet lever whenever the morse key pressed. The lever make a sound on touching nail Y. Whenever the morse key is not pressed, since the morse key and more sounder are in different place, one end of the machine is earthed. Earth acts as a conductor, we will make a sound in the more sounder on pressing and releasing morse key. Messages passes through this sound.

A Leclanche cell consists of a carbon electrode (anode) packed in a porous pot containing manganese dioxide and charcoal powder. The porous pot is immersed in a saturated solution of ammonium chloride (electrolyte) contained in an outer glass vessel. A zinc rod (cathode) is immersed in electrolytic solution.

At the cathode due to oxidation reaction Zn tom is converted into Zn++ ions and 2 electrons. Zn++ ions reacting with ammonium chloride will produces zinc chloride and ammonia gas. Ammonia gas escapes. The hydrogen ions diffuse through the pores of the porous pot and react with manganese dioxide. In this process the positive charge of hydrogen ion is transferred to carbon rod. When zinc rod and carbon rod are connected externally, current flows from carbon to zinc. The emf of cell is about 1.5V. Internal resistance is 5 ohms.

These type of cells are used in telephones, telegraphic equipments.

6.2.4. Dry cell

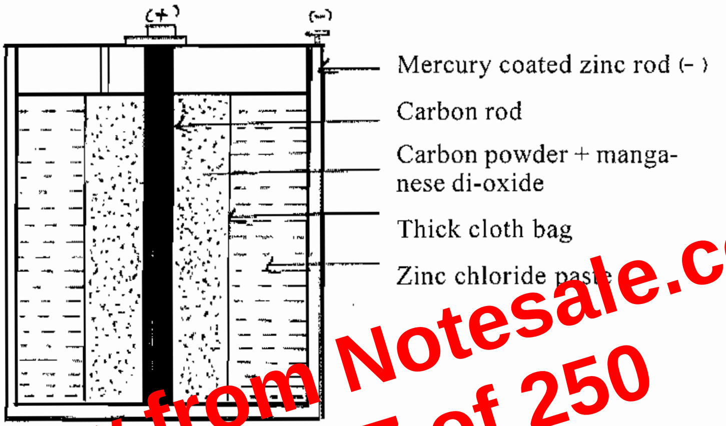


Fig 6.2.4

The glass jar in a Leclanche cell is replaced by a zinc container which itself acts as a negative electrode. The ammonium chloride solution is replaced by the moist paste made from a mixture of plaster of paris, ammonium chloride and zinc chloride called sal ammoniac paste. This forms the electrolyte of the cell. Zinc chloride is hygroscopic in nature and helps to maintain the moistness of the paste. The porous pot is replaced by a canvas wrapping. The carbon rod forms the positive electrode. This is surrounded by MnO2 and powdered carbon. The powdered Carbon reduced the internal resistance of the cell. The top of cell contains a layer of saw dust. This acts as the base for the top layer of bitumens used for sealing purposes. A vent is provided in this layer to allow the gases formed in the chemical reactions to escape. The emf of cell is 1.5V. These type of cells are used in torch lights, radios, wall clocks etc.

6.3. BATTERY

More than one or two cells when connected in series or parallel connection it is called as Battery. For example if a cell has 1.5V and if we need 3V or 6V then we can get it by connecting two cells or four cells. So cells are often arranged in groups to form batteries. There are two main methods in connecting them.

Series Method

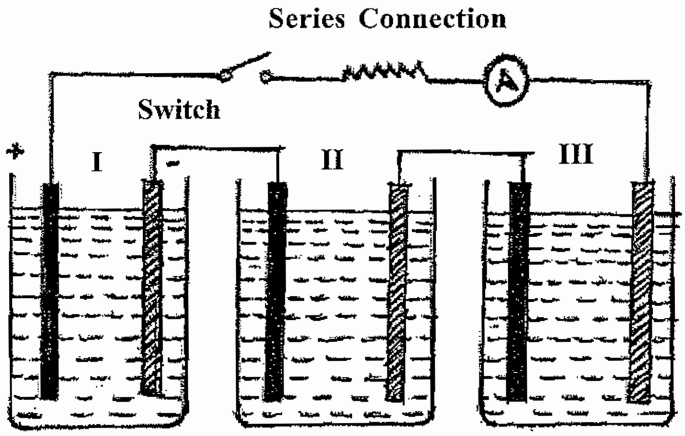


Fig. 6.3

The negative terminal of one is connected to the positive terminal of the next through out the battery. In this case the total voltage of the battery is the sum of the voltages of each cell. This method is employed in Telephone exchange, Telegraph etc.

6.3.1. Parallel Method

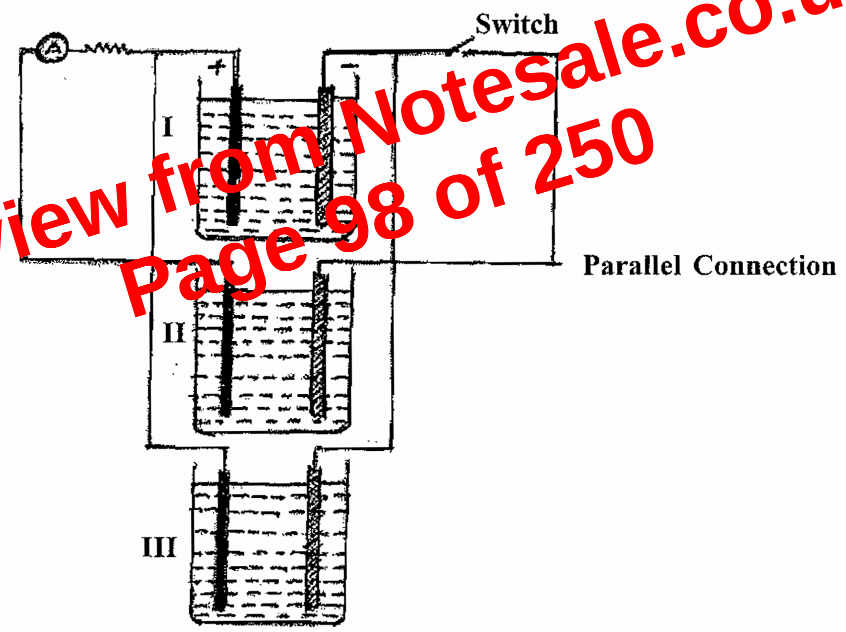


Fig. 6.3.1.

The negative terminals of the batteries are connected together and formed as one terminal and all the positive terminals are connected together and formed as another terminal. These terminals are output terminals of the battery. In this type, the voltage of the battery is equal to the voltage of the single cell. But the Ampere rating is high since it has less resistance. This battery will work even if any one of the cell is damaged or disconnected. This type is used where high ampere rating is needed.

Working principle

Firstly, a strong dc supply is given through positive and negative terminals. This current is passed for certain period of time. Now hydrogen is liberated at that set of plates connected to the negative of the source. This makes these plates spongy. At the positive plates, the liberated oxygen combines to form lead peroxide. This process is called charging. Charging process is done till the acid reaches its required specific gravity. If now the original source of current is disconnected and the two plates are connected to an ammeter, it shows the current flow.

The container is filled three parts of distilled water and one part of concentrated sulphuric acid. Before charging, the specific gravity of the acid should be 1.15 and after charging, the specific gravity should be 1.26. This can be measured by using hydrometer. The emf should be 2.25V

Chemical Reaction During Discharging

When the cell is discharging, current flows in the external circuit from positive to negative. The flow of current through the electrolyte splits into $H_2^+$and So_4^- ions.

- Both the positive and negative plates are slowly converted in to lead sulphate.
- Water is formed during discharge. So that the acid becomes more and more diluted.
- Decrease in emf.

Chemical Equation

During discharge

(Positive Plate)

Lead peroxide		Hydrogen		Sulphuric Acid		Lead Sulphate		Water
PbO_2	+	H_2	+	H_2SO_4		$PbSO_4$	+	$2H_2O$

(Negative Plate)

Pure lead	+	Sulphate	=	Lead sulphate
Pb	+	SO_4		$PbSo_4$

During Charge

Positive plate

Lead	+	Sulphate	+ Water	Lead peroxide + Sulphuric acid
$PbSo_4$	+	SO_4	$+ 2H_2O$	$PbO_2 + 2H2SO_4$

(Negative Plate)

lead Sulphate	+	Hydrogen		Lead	+	Sulphuric acid
$PbSO_4$	+	H_2		Pb	+	H_2SO_4

higher voltage (1.5V) and they are made for light loads. The loads can be continous, such as those encountered in hearing aids and electronic watches. Like the mercury cell, the silver oxide cell has good energy-to-weight and energy-to-volume ratios, poor low-temperature response, and flat output voltage characteristics. The structures of the mercuric and solver oxide cells are very similar. The main difference is that the positive electrode of the silver cell is silver oxide instead of mercuric oxide.

Lithium cells : The lithium cell is another type of primary cell. It is available in a variety of sizes and configurations. Depending on the chemicals used with lithium, the cell voltage is between 2.5 and 3.6V. Note that this voltage is considered higher than in other primary cells. Two of the advantages of lithium cells over other primary cells are :

- longer shelf life - upto 10 years

- higher energy-to-weight ratio upto 350 Wh/Kg

Lithium cells operate at temperatures ranging from -50 to +75°C. They have a very constant output voltage during discharge.

Uses : Primary cells are used in electronic products ranging from watches, Smoke alarms, cardiac pacemakers, torches, hearing aids, transistor radios etc.

6.7. STATIC UNINTERUPTABLE POWER SYSTEM (UPS)

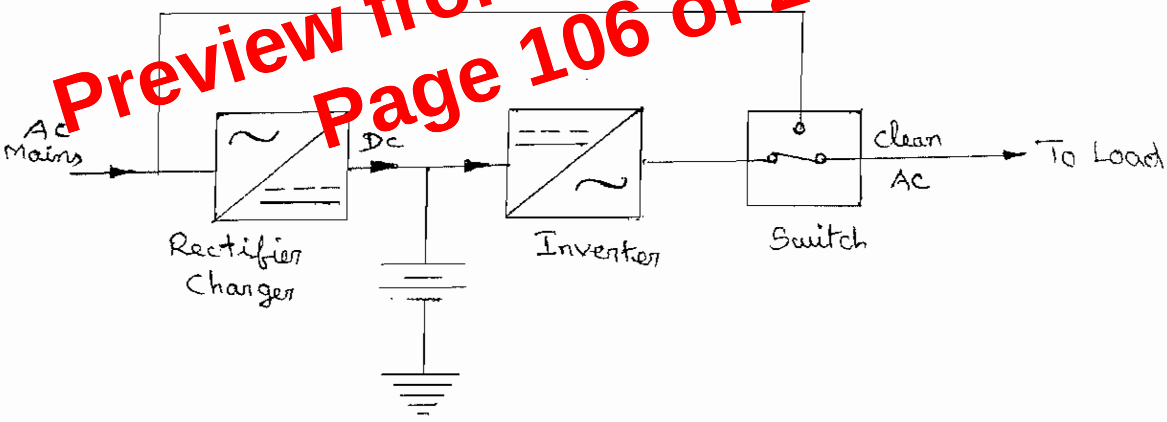


Fig. 6.7.

The function of a UPS is to ensure absolute continuity of power to the computerised control systems thereby protecting critical equipment from electrical supply failure. A UPS market is possible to provided a clean reliable supply of alternating current free of sags or surges i nthe line voltage, frequency variation, spikes and transients. UPS system achieve this by rectifying the standard main supply, using the direct current to charges the standby battery and to produce clean alternating current by passing through an inverter and filter system.

7.1. AC WAVE FORM AND ITS CHARACTERISTICS

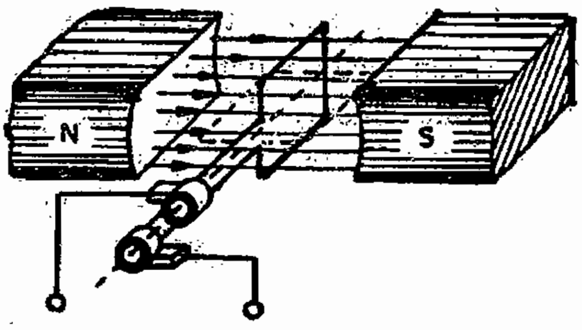


Fig. 7.1. (1)

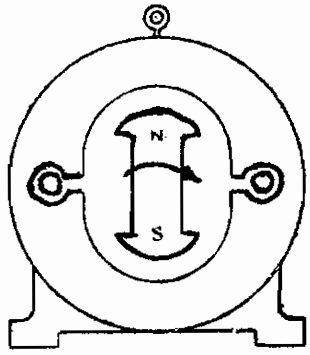


Fig. 7.1. (2)

In the figure (1) A coil fixed as to rotate in magnetic field.

In the figure (2) A magnetic field fixed as to rotate in side the coil.

If coil rotate in magnetic field or magnetic field rotate inside the coil there is an alternating emf generate in the coil. The generated alternating emf is proportional to the number of turns of coil, magnetic field strength, and the angle between the coil and magnetic field.

(i.e.) $e = Blv \sin \theta$

From this

l	=	Length of the conductor
v	=	Velocity of conductor.
B	=	Flux density.
θ	=	angle between field to conductor.
e	=	generated AC emf.

The generated AC emf value is depending upon the sine value of the angle between the magnetic field and conductor.

The sine wave may be drawn by taking the electro motive force in Y axis and time in X axis.

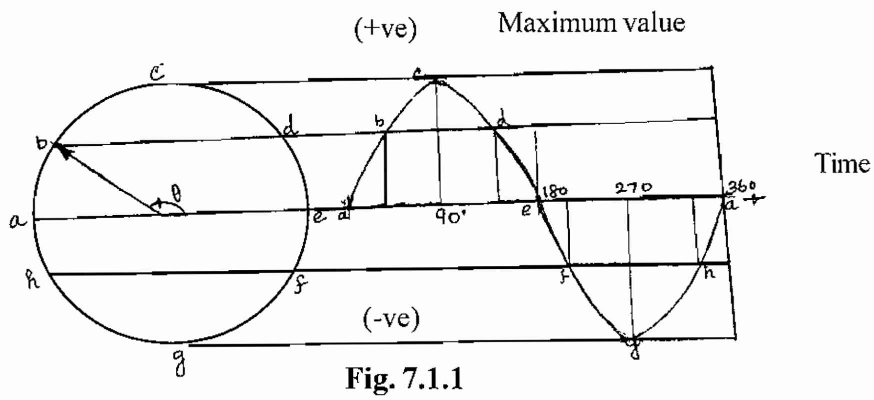


Fig. 7.1.1

7.2.13. Out of phase

If in AC circuit two quantities namely voltage or current waves get the maximum and zero at different time then they are said to be OUT OF PHASE.

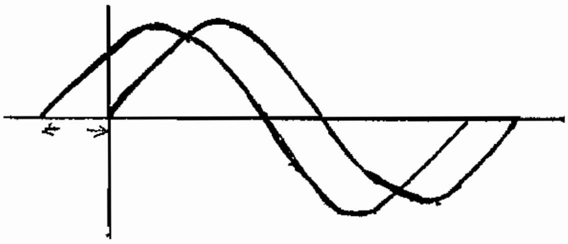


Fig. 7.2.13.

7.3. AC CIRCUIT WITH PURE RESISTANCE

A circuit without Inductance and capacitance is called pure Resistance circuit. The value of Resistance is R.

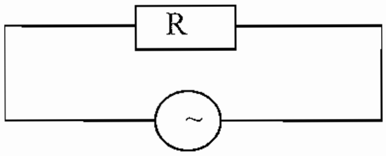


Fig. 7.3.

Instantaneous value of emf

$V = V_{max} \sin \omega t$

Current value = I Ampere.

When current passes through the circuit there is no counter emf created. The supply voltage and Resistance only in the circuit.

$$\text{Current} = \frac{\text{Electro motive force}}{\text{Resistance}}$$

I = E/R.

further in the circuit.

Power = current x emf and power factor always unit because the angle between the current and voltage is 0^0.

Because the power factor (Cos Φ) = 1.

7.3.1. Inductance

A long conductor wound round in the form of a coil is called an inductor. This has the property of inducing an emf when there is a change in the current passing through it. Its unit is henry and denoted by the letter "L".

7.3.1.1. Inductance in AC circuit

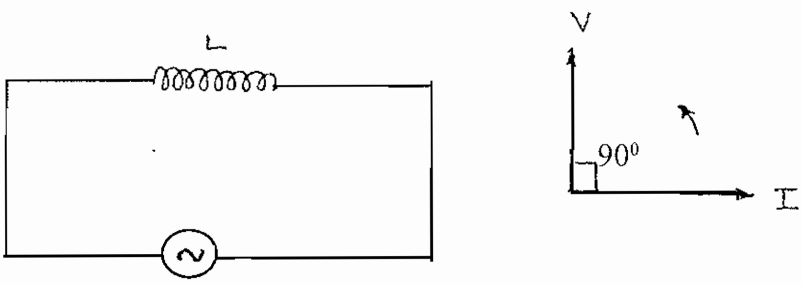


Fig. 7.3.1. (1)

7.3.5. Capacitive Reactance

The resistance offered by a capacitor is called as capacitive Reactance. The unit is Ohm (Ω) and denoted by letter Xc

$$Xc = \frac{1}{2\pi fc}$$

Xc = Capacitive reactance in ohm

C = Capacitance – in farad

f = frequency – in Hertz

7.3.6. Uses of capacitor

To improve the power factor in factory to smooth the line voltage, To improve power factor is tube light, Resistance welding, Induction motor, photo equipment are same place of using capacitor.

7.4. IMPEDANCE

The combined resistance in AC circuit offered by Resistance, Inductance and capacitance (Ω) any of the two is called Impedance. The unit is ohm. It is denoted by the letter Z.

7.4.1. Resistance and Inductance is AC circuit

The Resistance and Inductance are connected in series. There is no phase different in Resistance circuit But in the Inductance circuit the voltage is lead by 90⁰ to the current. The voltage across the resistance is V_R. Voltage across the inductance is V_L. Resistance value is R, Inductive Reactance value is X_L.

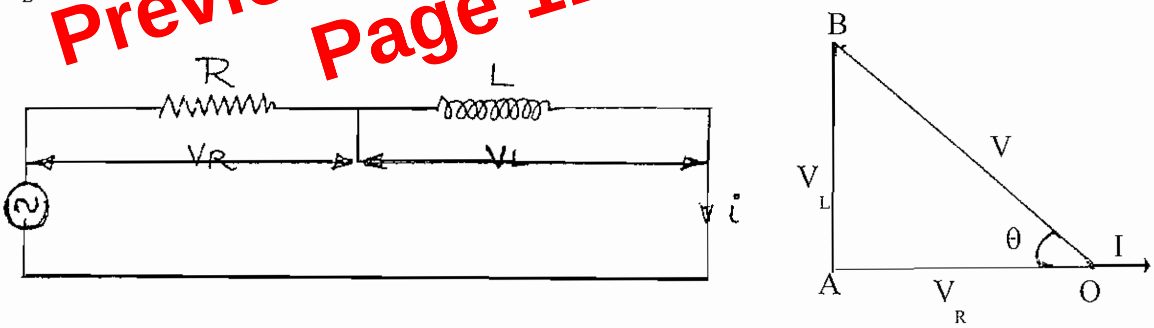


Fig. 7.4.1.

RL Circuit

RL Series Circuit - Phasor Diagram

$V = V_R + V_L$ (Vector sum)

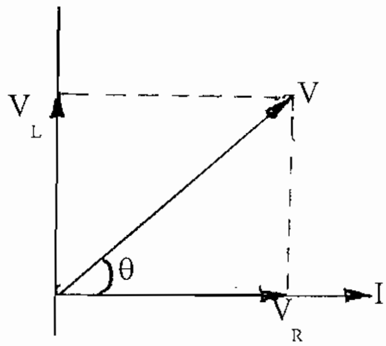


Fig. 7.4.1.

Ohm's Law

V = IR, I = Current

V_R = IR, V = Voltage

In this method similar ends (starting end or finishing end) of each phase winding are joined to.gether to form a common junction N and supply is taken from other three ends. The junction N is called star point or neutral point. The voltage between any one line and neutral is called phase voltage. Current flows through that phase is called phase current. Voltage between any two lines is called line voltage and current through that line is called line current.

In the star connection, phase current = Line current

$$\text{i.e.} I_{ph} = I_L$$

$$\text{Phase voltage} = \frac{\text{Line voltage}}{\sqrt{3}}$$

7.10.2. Delta or Mess Connection

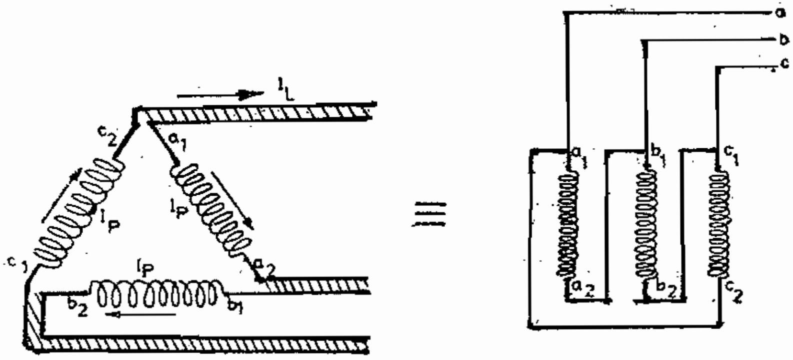


Fig.7.10.2.

If the six ends of three phases are so connected that one end of first coil is connected to start end of the second coil and so on, a closed mesh will be formed. If three lines are taken from the three connected points, then this method is called delta connection.

As only one phase winding is in between any two lines, phase voltage will be equal to the line voltage.

Phase Voltage = Line Voltage

Phase Current = Line Current/$\sqrt{3}$

Therefore, 3 phase power = $\sqrt{3}$ VI cosθ

7.11. TWO WATT METER METHOD OF MEASURING POWER AND POWER FACTOR

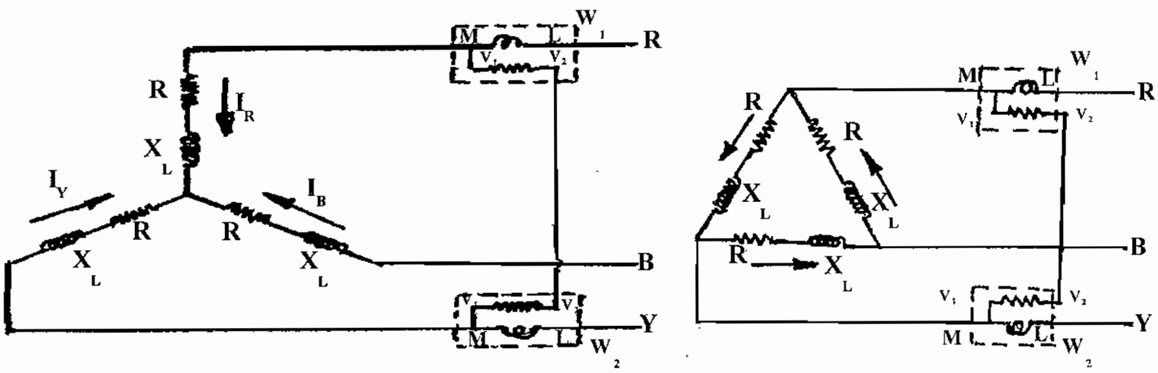


Fig. 7.11.

7.15. MOVING COIL INSTRUMENTS:

They are two types

1. Permanent magnet type.
2. Dynamo meter type.

7.15.1. Moving coil permanent magnet type

Ammeter and Voltmeter

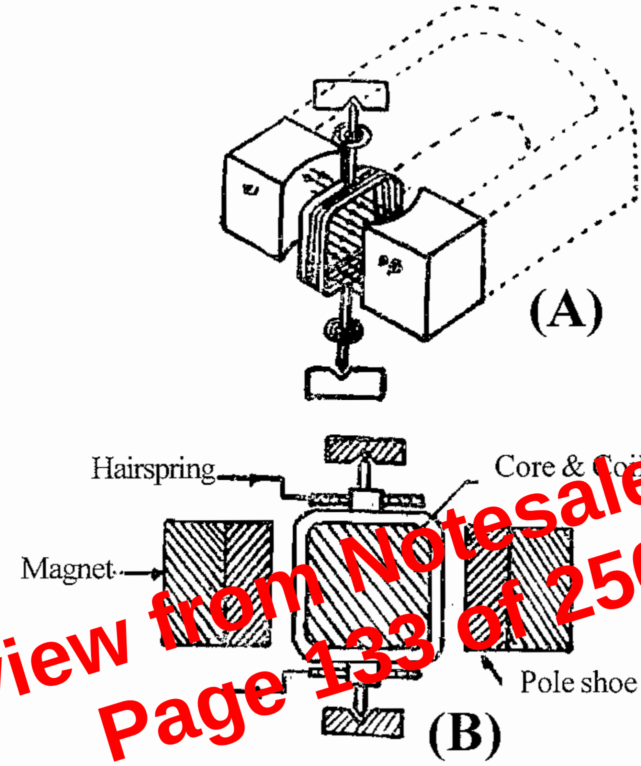


Fig. 7.15.1.

This type of Instruments function by the principle. When a current carrying conductor is placed in a magnetic field, there is a force is induced in the conductor. This force moves the conductor any direction and replace from magnetic field.

The construction is as shown in the figure. The soft Iron magnetic piece is fixed in the end of the "U" shaped permanent magnet. A cylinder shaped Iron core is fixed between the magnetic poles. A rectangular coil wounded on the aluminium or copper frame is fixed in the air gap.

Two spiral shaped phosphor Bronze hairsprings are fixed. On the top, and bottom of the coil. They are used to carry the coil current and give the controlling torque to the coil

The aluminium frame not only provides support for the coil but also provides damping by eddy current induced in it. This construction may be used in voltmeter and Ammeter. When is used as Ammeter the circuit current or the part of circuit current is pass through the coil. When it is used as voltmeter the current through the coil is proportional rate of circuit voltage. The magnetic field by coil current is repulled by the permanent magnet's magnetic field and the Deflecting torque is induced in the coil. This Deflecting torque is proportional to the coil current so the scale is uniform division Deflecting Direction is according to the coil current direction.

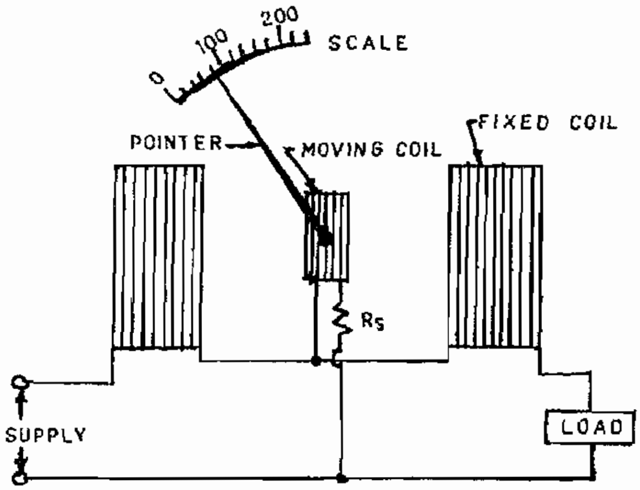


Fig. 7.16.

When the meter used as Ammeter the load current or the part of the load current passes through the coil,. When the meter used as voltmeter the current proportional to the voltage is posses through the coil. The current induces the Deflecting torque.

This deflecting torque is proportional to the square of the current passes through it. So this type of meters are used in alternating and direct current. The scales are not uniform if the meter is used as ammeter or voltmeter particularly crowded nears zero.

Because of the air core the field strength is very low. More coil turns is necessary to induce for particular deflecting torque. And so for the hairspring is very thin the very small amount of current can be send through the coil. So more turns of coil are necessary. The above two factors the weight of the moving part is increased and the friction increased compared to other meter. The sensitivity is very low due to torque / weight ratio.

This type of meters is very costly. There in no eddy current and hysteresis error upto 10 A Ammeter and 600 V Voltmeter are manufacture with high sensitivity.

7.17. MOVING IRON INSTRUMENTS

The are two type

1. Attraction type
2. Repulsion type

7.17.1. Attraction type

This type of instruments is operated in the principle of Iron piece in attracted by a magnet. As shown in the figure when current passes through a coil a magnetic field is induced. An oval shaped soft iron piece is fixed in a spindle, which is fixed in between two bearings near the coil. As a pointer is fixed in the spindle when the soft iron moves towards the magnetic field the pointer moves on the scale. The deflection of the pointer depends upon the coil current. Though the current is in any direction in the coil the iron moves only towards the magnetic field. So this type of instrument is used both in AC and DC.

This figure shows the air friction damping and gravity control is used in this type.

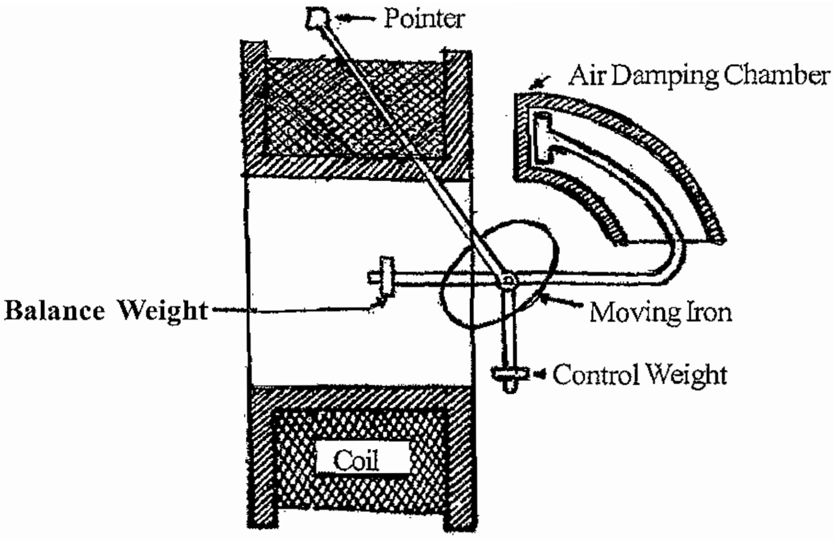


Fig. 7.17.2.

7.17.2. Repulsion Type

The construction of the instrument is shown in the figure. Two soft iron pieces are fixed in parallel in centre of the coil. In it one piece is fixed and the other is movable. This movable piece is fixed with the spindle.

When this instrument is used as an Ammeter, these iron pieces are magnetised with same pole effect by the load current passes through the coil.

When this instrument is used as a voltmeter these iron pieces are magnetised with same pole effect by the current proportional to the circuit voltage.

These iron pieces are magnetised as the pole on the top and south pole the bottom. Due to the same pole effect, as by the repulsion principle the moving iron is repulled by the fixed iron. This depletion depends upon the coil current.

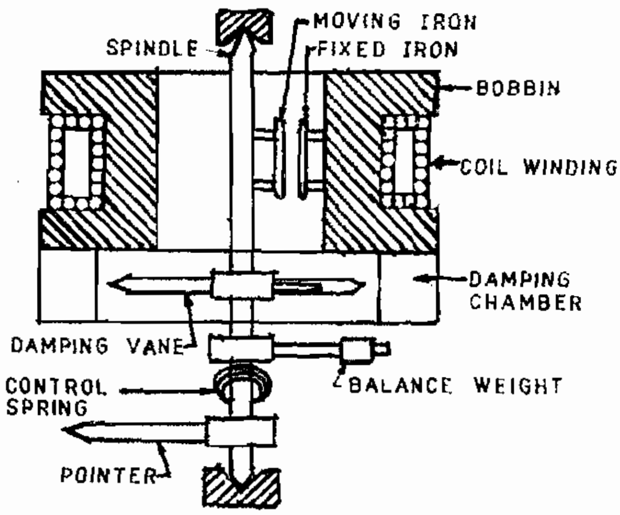


Fig.7.17.2.

As the moving iron is fixed with the spindle, the pointer moves on the scale when the spindle moves. Though the current is in any direction the iron pieces are magnetised with same pole effect. So the spindle rotates regularly in one direction. So, this instrument is used in both AC and DC.

If plates are used instead of iron piece, the measurements are accurate. This figure shows that damping torque is got from air friction damping. The controlling torque is got from gravity control.

7.17.3. Errors in moving Iron Instruments

Generally two types of errors occur in this type of instrument.

1. Errors due to direct current and Alternative current.
2. Error only due to AC.

1. Error occurs due to AC / DC

(i) Due to Hysteresis lose in the moving iron the measurements differ. To avoid this hysteresis loses, the low hysteresis loss metals such as Mumetal and Permallay C are used.

(ii) Due to stray magnetic field the measurements are not shown accurately. To avoid it, magnetic screening is formed using metal seal.

2. Errors due to AC only

(i) Frequency error occurs normally due to AC. As the frequency changes the impedence of the coil changes. And the amount of eddy current changes.

(ii) Due to these change errors occurs to avoid this error a capacitor equal to the coil resistance is connected with the circuit.

7.17.4. Advantages

(i) High deflecting Torque.

(ii) Used both in AC and DC

(iii) It is cheaper and reliable

(iv) It is suitable to be used in high capacity and in low frequency.

(v) As the moving parts don't need current this instrument is robust.

Disadvantages

(i) Hysteriesis lose and stray magnetic loss occurs.

(ii) The scales are not uniform

(iii) While used in AC supply.

The frequency in which it is calibrated, it works accurately.

(iv) As the heat increases, the stiffness of the hairspring reduces.

7.19.4. Wheat stone Bridge method

This method is very accurate. The P, Q, R and unknown resistance X is connected as shown in the figure. The R is variable resistance. The variable supply voltage is connected to the point A and C. The Galvano meter is connected between the terminal B and D. The Galvano meter is pointed at Null point by changing the voltage and variable resistance. At null point the current through the arm A to B and C to D is equal. So the potential different between A to B is

= Current x Resistance

= $I_1 \times P$.

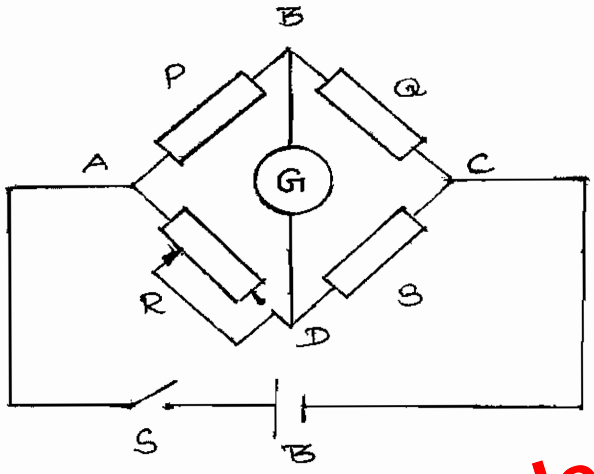


Fig. 7.19.4.

as the same. A to D the potential different.

= Current x Resistance

= $I_2 \times R$

Potential Different at A to B = Potential Different at A to D.

$= I_1P = I_2R.$

Hence $\frac{P}{R} = \frac{I_2}{I_1}$ ———— (1)

Hence $\frac{Q}{X} = \frac{I_2}{I_1}$ ———— (2)

In the equation (1) and (2) $\frac{I_2}{I_1}$ is equal

Therefore $\frac{P}{R} = \frac{Q}{X}$

Therefore $X = \frac{RQ}{P}$

7.20. OHM METER (MEDIUM RESISTANCE)

The range between one ohm to 100 k ohm are called medium resistance. They are measured by ohm meter.

Ohm meter is used to measure the Resistance, Current, Voltage and Continuity of the electric wires directly.

7.20.1. Series Type Ohm meter

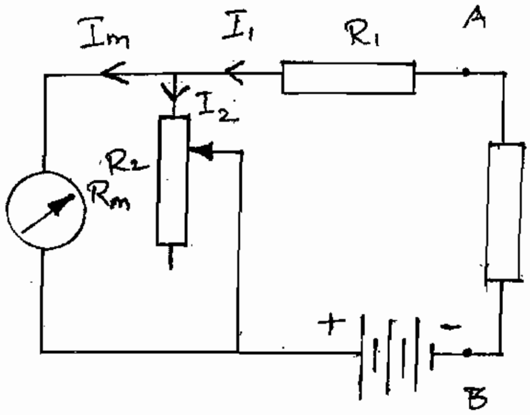


Fig 7.20.1.

Fig shows the circuit diagram of series type ohm meter. In this, a galvanometer is parallely connected to the rheostat R_2 and this setup is connected to the resistor R_1 in series. This circuit is connected to the point AB through a battery for measuring the value of resistance connected across the point AB. When the supply is given from the battery, the current will flow through the galvanometer and the pointer is deflected to show the readings. If the circuit is opened, there is no current flow in the galvanometer and the pointer is in zero position. This is denoted as ∞. The voltage of the battery is reduced depending upon the usage.

7.20.2. Shunt type Ohm meter

In this circuit, galvanometer is connected to the rheostat R_1 and battery E in series connection. The terminals of the galvanometer is connected to the unknown resistance. When the point AB is short circuited, then Rx = 0 and the current flowing through the galvanometer is zero. If AB is opened, the whole current will flow through the galvanometer. This type of meters are used to measure the low resistance value.

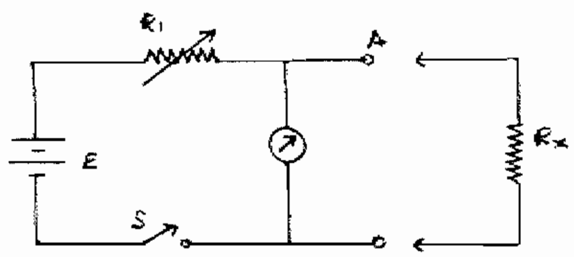


Fig. 7.20.2.

In shall type, there are two parallel magnetic paths into which the flux the central limb can divide.

The primary and secondary windings are placed on the central limb one above the other. This gives a better magnetic coupling. The magnetic circuit is made of laminated iron core. In a shell type transformer, the core surrounds the windings. In general the shell type is more economical for low voltage transformers and the core type construction is more suited for high voltage transformers.

Coil assembly

For a given area, to have minimum periphery so as to reduce the cost of winding wire and for easy construction. Cylindrical coils are used. A stopped core is used. The core laminations are bolted together. The bolts are insulated from the core to avoid eddy currents by employing Synthetic Resin Bonded Paper (SRBP) tubes. In each limb, a stiffening plate is used to prevent bulging of laminations between bolts. Surrounding the limb, SRBP cylinder is placed. This supports the L.V. winding is provided near the core, to reduce the heavy insulation. Spacers are provided between L.V. and H.V. windings. Thus cooling ducts are formed. This ensures free flow of coils. L.V. and H.V. windings are insulated from each other by bakelite cylinders. The bottom yokes have clamping channels.

The entire core is first built up. The top yoke is pulledout one by one. The already wound L.V. and H.V. windings are placed over the limbs along with insulating cylinders. The top yoke is then put in position and clamped.

EMF Equation of a Transformer:

Let a transformer have,

Primary turns = N1

Secondary turns = N2

Maximum value of flux in the core linking both the windings = ? m in webers

Frequency of a.c input in H.Z = f.

The flux in the core will very sinusoidally as shows in figure 8.7.

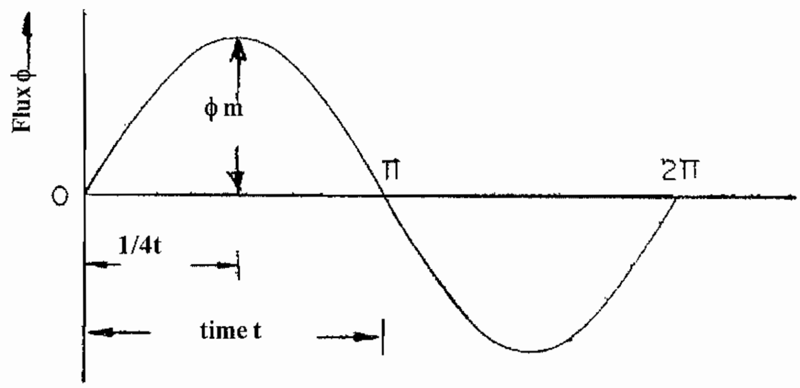
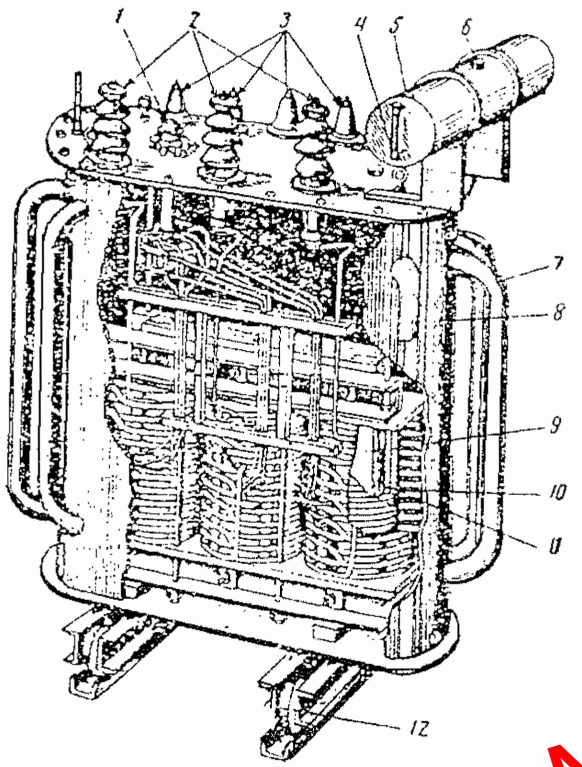


Fig. 8.7.

these high voltages are stopped down by 3 phase transformers to 11 KV. This is further stepped down to 400 volts at load centres by means of distribution transformers. For generation, transmission and distribution, 3 phase system is economical. Therefore 3 phase transformers are very essential for the above purpose. The sectional view of a 3 phase power transformer is shown in Fig : 8.9.



1. Tap-changer switch handle
2. Porcelain-bushing insulator (For high voltage)
3. Bushing insulators (For low voltages)
4. Oil gauge
5. Oil tank
6. Breather plug
7. Cooling pipes
8. Tank front wall
9. Core,
10. High voltage winding
11. Low voltage winding
12. Wheels or rollers.

Fig 8.9 100 KVA oil immersed power transformer

Construction of Three phase Transformer

Three phase transformers comprise of three primary and three secondary windings. They are wound over the laminated core as we have seen in single phase transformers. Three phase transformers are also of core type or shell type as in single phase transformers. The basic principle of a three phase transformer. Is illustrated in fig. 8.10 in which only the primary windings are shown. They are inter connected in star and put across three phase supply.

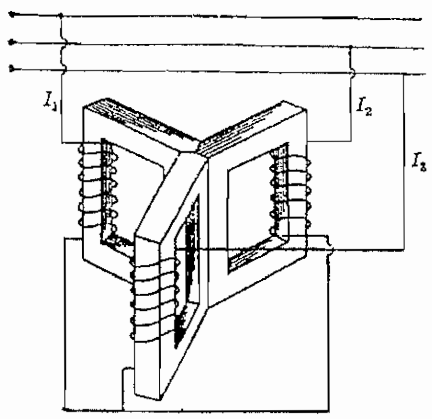


Fig 8.10 : 3-phase core-type Transformer

The three cores are 120° apart and their unwound limbs are shown in contact with each other. The centre core formed by these three limbs, carries the flux produced by the three phase currents I_R, I_Y and I_B. As at any instant $I_R+I_Y+I_B=O$, the sum of three fluxes (flux in the centre limb) is also zero. Therefore it will make no difference if the common limb is removed.

The core type transformers are usually wound with circular cylindrical coils. The construction and assembly of laminations and yoke of a three phase core type transformer is shown in fig : 8. 11. one method of arrangement of windings in a three phase transformer is shown in fig: 8.12. In this fig, the primary windings occupy the bottom portion of each limb.

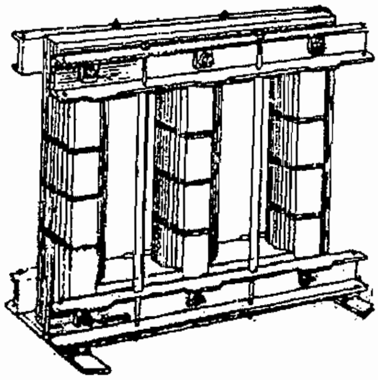


Fig. 8.11

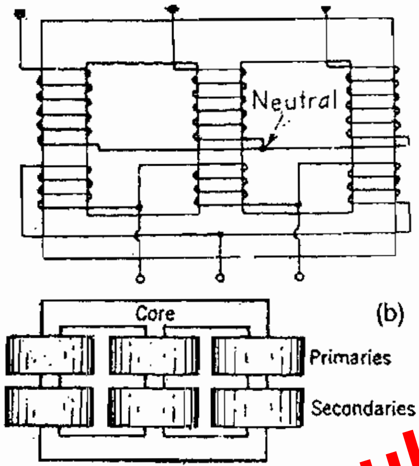


Fig. 8.12

In the other method the primary and secondary windings are wound one over the other in each limb. The low-tension windings are wound directly over the core but are, of course, insulated for it. The high tension windings are wound over the low - tension windings and adequate insulation is provided between the two windings.

The primary and secondary windings of the three phase transformer can also be interconnected as star or Delta.

Three Phase Transformer connections:-

The identical single phase transformers can be suitably inter-connected and used instead of a single unit 3–phase transformer. The single unit 3 phase transformer is housed in a single tank. But the transformer bank is made up of three separate single phase transformers each with its own, tanks and bushings. This method is preferred in mines and high altitude power stations because transportation becomes easier. Bank method is adopted also when the voltage involved is high because it is easier to provide proper insulation in each single phase transformer.

As compared to a bank of single phase transformers, the main advantages of a single unit 3-phase transformer are that it occupies less floor space for equal rating, less weight costs about 20% less and further that only one unit is to be handled and connected.

There are various methods available for transforming 3 phase voltages to higher or lower 3 phase voltages. The most common connections are (i) star – star (ii) Delta – Delta (iii) Star – Delta (iv) Delta – Star.

In parallel across a supply system of proper voltage, and their secondaries are connected to separate or independent circuits as in Fig : 8. 17. they operate independently of each other. When the secondaries are also connected in parallel as in Fig : 8.18, the transformers must have the same rated primary and secondary voltages. Otherwise the secondary emfs will be unequal, and a current will circulate between the machines, This current is to be limited only by the impedance of their windings. Since this impedance is small, such a light difference in secondary EMF will cause a large current to circulate. Therefore in connecting two or more than two transformers in parallel, it is essential that their terminals of similar polarities are joined to the same bus bars.

In order that the transformers may properly divide the load, the impedance drop in each must be the same at all loads. Thus each transformer must have the same percentage impedance. In general transformers will share the load inversely proportional to their respective impedances. For instance, if two transformers of the same rated KVA are to equally divide the load, they should have the same impedance. If one has twice the KVA rating of the other, it should supply twice the current. (the impedance of the higher rating transformer should have lower value compared to the other, because voltage drops should be same in both the transformers).

Conditions for satisfactory parallel Operation:

The following conditions should be fulfilled for the satisfactory parallel operation of transformers.

1) Polarity of transformers should be same. In case polarity is wrong, a dead short circuit may occur.

2) Equal voltage ratio is required to avoid local circulating currents between the transformer windings. With unequal voltage ratios the secondary voltages on no-load will not be equal. When secondaries are connected in parallel, circulating current will flow.

3) The percentage impedance (Percentage voltage drop due to impedance of winding) of the transformer should be equal. For paralling 3. phase transformers in addition to the above points, the following conditions must also be fulfilled.

4) In case of 3 phase transformers, phase sequence should be same.

5) The transformers to be connected in parallel should belong to the same vector group.

Instruments Transformers

In D.C. circuits when high voltages are to be measured, low-range voltmeters are used with a high resistance connected in series with them. For measuring large currents, it is usual to use low range ammeters with suitable shunts. But in alternating current systems of high and moderate voltage, meter relays and other instruments are not usually connected directly to the power circuit. For this purpose, specially constructed instrument transformers known as are employed. By means of these transformers ordinary instruments of 150 Volts potential and 5 ampere current coils can be used to indicate accurately the voltage, current and power etc., in such circuits regardless of the line voltage or of the current they carry. Also low energy relays can be employed to operate protective and control apparatus.

9. D.C. GENERATOR

D.C. Machines can be used as a generator or as a motor. Hence D.C. Machines are classified in to:

i) D.C. Generator and

ii) D.C. Motor.

Basic Principle of DC Generator and Energy Conversion:

In general, an electrical generator is a rotating machine which converts mechanical energy into electrical energy.

D.C. generators work on the principle of electromagnetic induction. This is explained as follows.

According to Faraday's Laws of Electro-Magnetic Induction, when a conductor or a coil is rotated in a magnetic field in such a way, to cut the magnetic lines of flux, an e.m.f. is induced in a conductor or in the coil. If the circuit of the conductor or coil is closed in proper way, a current flows through the circuit. The magnitude of induced e.m.f. is proportional to the speed of rotation of the conductor, the flux in the magnetic field and the number of conductors or coils connected in series.

In d.c. generators the conductor or the coils are arranged on a cylindrical rotor called an armature. The armature is rotated in the magnetic field so as to cut the magnetic lines of flux. To rotate this armature, another rotating device called prime-mover is used. The prime movers used for this energy conversion may be water turbine or diesel engine or steam engine. The armature of the d.c. generator is driven by mechanical energy applied to its shaft. Thus the mechanical energy is converted in to electrical energy. Fig: 9.1.

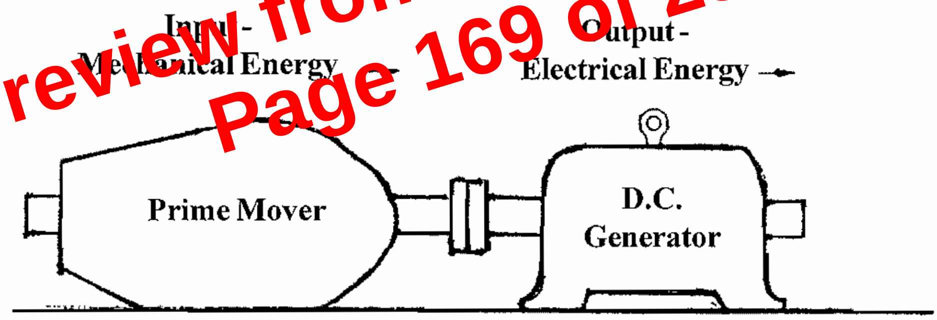


Fig. 9.1. Illustration of Energy conversion

The D.C. machine (D.C. generator or D.C. motor) has the following parts.

1. Poles or field poles to produce the magnetic flux.
2. An armature with conductors and
3. Relative motion between magnetic field and armature conductors.

In d.c. generators the magnetic field is stationary and the armature rotates. When the armature is rotated, the armature conductor cut the magnetic lines of flux, so a dynamically induced e.m.f. is induced in the armature. The e.m.f. thus induced in d.c. generator is of alternating one and this is converted in to direct e.m.f. by a device known as "Commutator". The Commutator is mounted at the one end of the

The Yoke serves two purposes

1. It provides Mechanical support to poles acts as a protecting cover for the machine.
2. It carries the magnetic flux produced by the poles

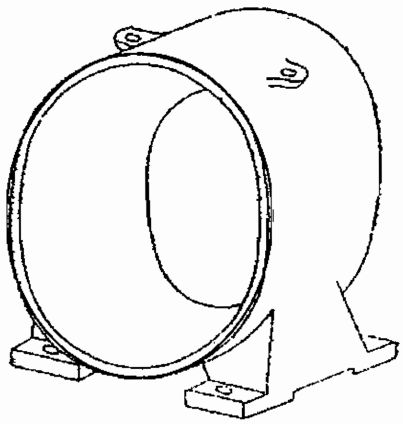


Fig. 9.3. (a) Yoke

Field Poles:

Laminated steel sheets are used to fabricate poles. The sheets are stacked for the required length and reveted together. The poles are fixed at the inner periphery of the hollow cylindrical frame. One each pole a former wound coil is provided. Insulated copper wire is used for the coils. The coils of all the poles are connected in such a way to form north and south pole alternatively. These are called field poles. When the wise of the coils carries a current, the pole become an electro-magnet and produces the magnetic flux. The purpose of providing pole shoes in the poles are

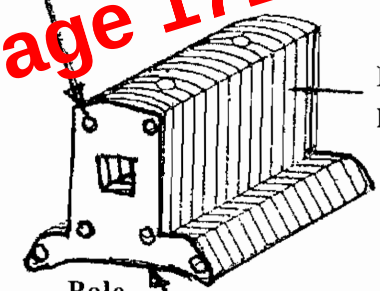


Fig. 9.3 (b) Pole

(i) It act as a mechanical support to the field coils.

(ii) They reduce the reluctance of the magnetic path and

(iii) They guide and spread out the flux in the air gap.

Inter Poles:-

Inter poles or the commutating poles are fixed to the frame as shown in fig: 9.2. These poles are provided to improve commutation. The winding of the interpole is connected in series with armature.

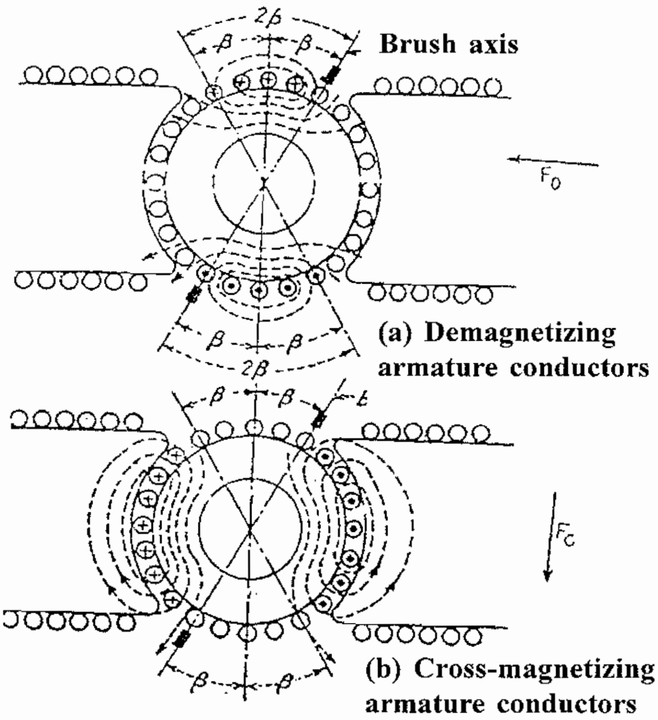


Fig. 9.17

The demagnetising component is in phase opposition to the field MMF. This reduces the main field flux.

The cross magnetising component is at right angles to the field MMF. This changes the direction of the main field flues. The exact conductors which produce these two effects are shown in figure. 9.17 Due to the effect of these two components of the armature MMF, the resultant MMF has increased (Fig. 9.18).

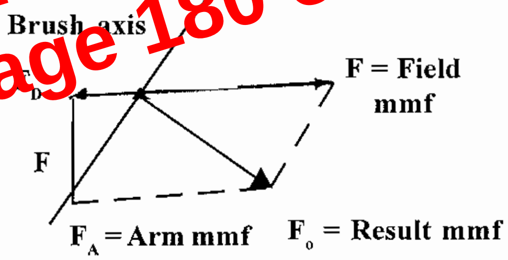


Fig. 9.18

Methods of Compensating Armature Reaction:-

(i) Increasing the Air Gap Length.

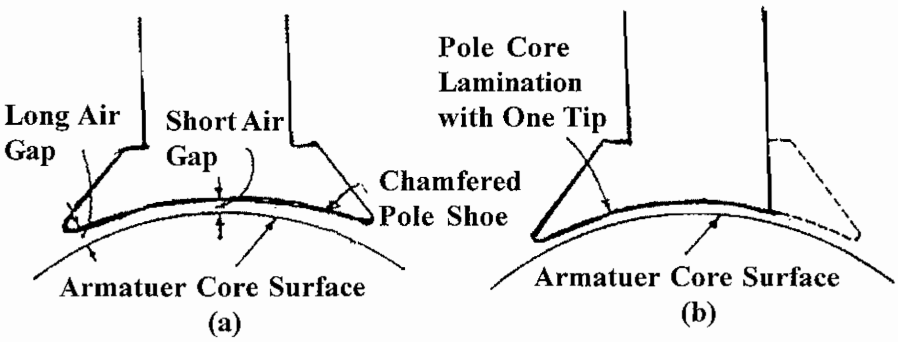


Fig. 9.19 Special pole-core laminations to counteract the effect of armature reaction

Hence the flux can be decreased and consequently the speed of the motor is increased. The minimum speed is obtained by completely removing the resistance in the diverter circuit.

(2) Armature Diverter Method:

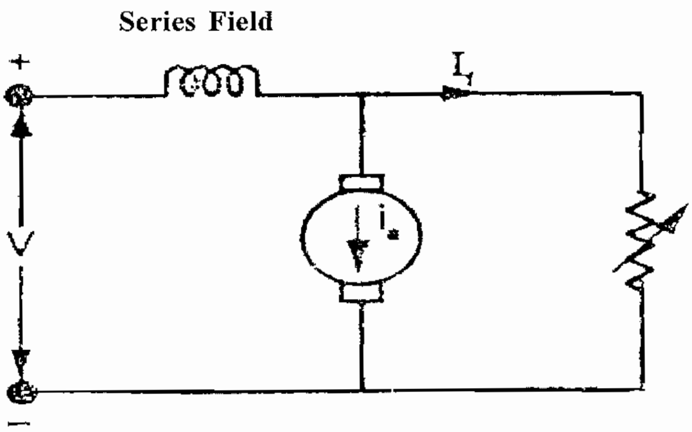


Fig. 10.14

In this method a variable resistance known as diverter is connected in parallel with the armature as shown in fig. 10.14. The armature current can be varied by adjusting the diverter resistance.

For a constant load if Ia is reduced using armature diverter, then the flux Ø has to be increased to produced the same tosque as T αØ Ia. To satisfy this condition, current drawn from the mains will be more to increase the flux. Thus when the flux increases, then the speed increases. The variations in speed can be obtained by varying the diverter resistance.

(3) Tapped Field Control

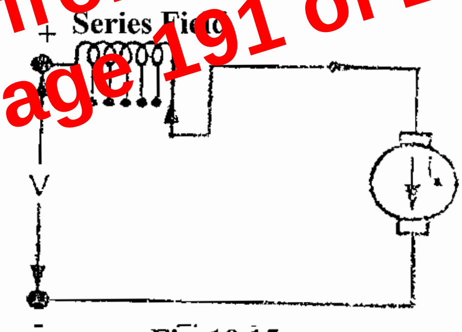


Fig. 10.15

This method is often used in electric traction and is shown in fig. 10.15.

The number of series field turns in the circuit can be changed at our will. With full field winding in the circuit the motor runs at its minimum speed. The speed can be raised in steps by cutting out same of the series turns.

(4) Variable Resistance in series with motor:

By increasing the resistance in series with the armature, the voltage applied across the armature terminals can be decreased. If the voltage across the armature is reduced speed is also reduced. However it will be noted that, when full load current of the motor passes through this resistance, there is a considerable loss of power in it. The circuit diagram for this operation is shown in fig. 10.16.

When the motor has come upto about 75 to 80% of synchronous speed, the starting winding is opened by a centrifugal switch and the motor will continue to operate as a single phase motor.

At the point where the starting winding is disconnected, the motor develops nearly as much torque with the main winding alone as with both windings connected. This can be observed from, the typical torque-speed characteristics of this motor, as shown in Fig:12.3.

The direction of rotating of a split-phase motor is determined by the way the main and auxiliary windings are connected. Hence, either by changing the main winding terminals or by changing the starting winding terminals, the reversal of direction of rotating could be obtained.

APPLICATIONS

These motors are used for driving fans, grinders, washing machines, and wood working tools.

12.4. CAPACITOR-START, INDUCTION-RUN MOTOR

A drive which requires a large starting torque may be fitted with a capacitor-start, induction-run motor as it has excellence starting torque as compared to the resistance-start, induction-run motor.

CONSTRUCTION AND WORKING

Fig:12.4(a) shows the schematic diagram of a capacitor-start, induction-run motor. As shown, the main winding is directly connected across the main supply whereas the starting winding is connected across the main supply through a capacitor and centrifugal switch.

Both these windings are placed in a stator slot at 90 degree electrical apart, and a squirrel cage type rotor is used.

As shown in Fig:12.4(b), at the time of starting the current in the main winding lags the supply voltages by 90 degrees, depending upon its inductance and resistance. On the other hand, the current in the starting winding due to its capacitor will lead the applied voltage, by say 20 degrees.

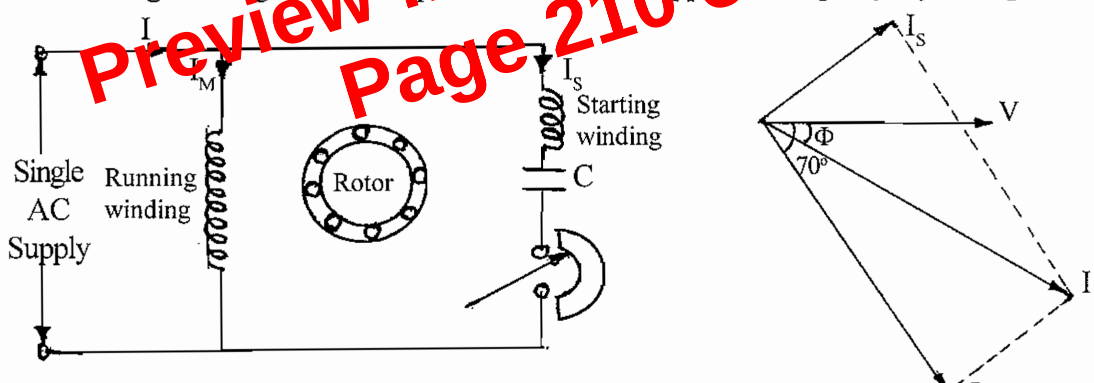


Fig:12.4

Hence, the phase difference between the main and starting winding becomes near to 90 degrees. This in turn makes the line current to be more or less in phase with its applied voltage, making the power factor to be high, thereby creating an excellent starting torque.

However, after attaining 75% of the rated speed, the centrifugal switch operates opening the starting winding and the motor then operates as an induction motor, with only the main winding connected to the supply.

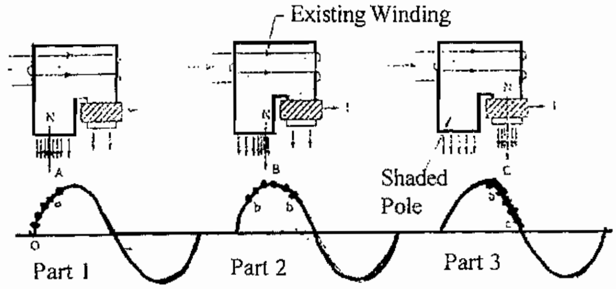


Fig:12.9.

When the current raises from "Zero" Value of point "O" to a point "a" the change in current is very rapid (Fast). Hence, it reduces an emf in the shaded coil on the basis of Faraday's law of electromagnetic induction.

The induced emf in the shaded coil produces a current which, in turn, produces a flux in accordance with Lenz Law. This induced flux opposes the main flux in the shaded portion and reduces the main flux in that area to a minimum value as shown in Fig:12.9.

This makes the magnetic axis to be in the center of the unshaded portion as shown by the arrow in part of fig:12.9. On the other hand as shown in part 2 of 3 when the current raises from point "a" to point "b" the change in current is slow the induced emf and resulting current in the shading coil is minimum and the main flux is able to pass through the shade portion.

This makes the magnetic axis to be shifted to the center of the whole pole as shown in by the arrow in part 2 of Fig:12.9.

In the next instant, as shown in part 3 of Fig:12.9, when the current falls from "b" to "c" the change in current is fast but the change of current is from maximum to minimum.

Hence a large current is induced in the shading ring which opposes the diminishing main flux, thereby increasing the flux density in the area of the shaded part. This makes the magnetic axis to shift to the right portion of the shaded part as shown by the arrow in part.

From the above explanation it is clear the magnetic axis shifts from the unshaded part to the shaded part which is more or less a physical rotary movement of the poles.

Simple motors of this type cannot be reversed. Specially designed shaded pole motors have been constructed for reversing operations. Two such types:

a. The double set of shading coils method

b. The double set of exciting winding method.

Shaded pole motors are built commercially in very small sizes, varying approximately from 1/250 HP to 1/6 HP. Although such motors are simple in construction and cheap, there are certain disadvantages with these motor as stated below:

- Low starting torque.
- Very little overload capacity.
- Low efficiency.

Providing commutating interpoles in the stator and connecting the interpole winding in series with the armature winding. Providing high contact resistance brushed to reduce sparking at brush positions.

OPERATION

A universal motor works on the same principles as a DC motor i.e. force is created on the armature conductors due to the interaction between the main field flux and the flux created by the current carrying armature conductors. A universal motor develops unidirectional torque regardless of whether it operated on AC or DC supply.

Fig:12.12 shows the operation of a universal motor on AC supply. In AC operation, both field and armature currents change their polarities, at the same time resulting in unidirectional torque.

CHARACTERISTICS AND APPLICATIONS

The speed of a universal motor inversely proportional to the load i.e. speed is low at full load and high, on no load.

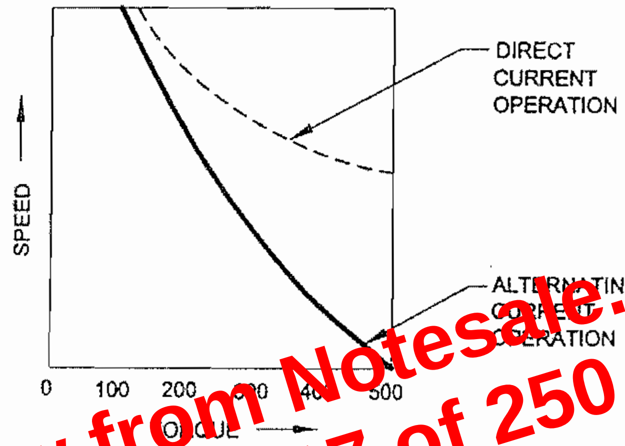


Fig:12.13

The speed reaches a dangerously high value due to low field flux at no loads in fact the no load speed is limited only by its own friction and windage losses. As such these motors are connected with permanent loads or gear trains to avoid running at no load thereby avoiding high speeds.

Fig:12.13 shows the typical torque-speed relation of a universal motor, both for AC and DC operations. This motor develops about 450 % of full load torque at starting, as such higher than any other type of single phase motor. Universal motors are used in vaccum cleaners, food mixers, portable drills and domestic sewage machines.

CHANGE OF ROTATION

Direction of rotation of a universal motor can be reversed by reversing the flow of current through either the armature or the field windings. It is easy to interchange the leads at the brush holders.

However, when the armature terminals are interchanged in a universal motor having compensating winding, care should be taken to interchange the compensating winding also to avoid heavy sparking while running.

12.14. THREE PHASE INDUCTION MOTOR

INTRODUCTION

The most common type of AC motor being used throughout the work today is the "Induction Motor". Applications of three-phase induction motors of size varying from half a kilowatt to thousands of kilowatts are numerous. They are found everywhere from a small workshop to a large manufacturing industry.

The advantages of three-phase AC induction motor are listed below:

- Simple design
- Rugged construction
- Reliable operation
- Low initial cost
- Easy operation and simple maintenance
- Simple control gear for starting and speed control
- High efficiency.

Induction motor is originated in the year 1891 with crude construction. Then an improved construction with distributed stator windings and a cage rotor was built.

The slipring rotor was developed after a decade or so. Since then a lot of improvement has taken place on the design of these two types of induction motors. Lot of research work has been carried out to improve its power factor and to achieve suitable methods of speed control.

PRINCIPLE OF 3 PHASE INDUCTION MOTOR

Induction motor works on the same principle as a DC motor, that is, the current carrying conductors kept in a magnetic field will tend to create a force.

However the induction motor differs from the DC motor in the fact that the rotor of the induction motor is not electrically connected to the stator, but induces a voltage/current in the rotor by the transformer action, as stator magnetic field sweeps across the rotor.

The induction motor, derives its name from the fact that the current in the rotor is not drawn directly from the supply, but is induced by the relative motion of the rotor conductors and the magnetic field produced by the stator currents.

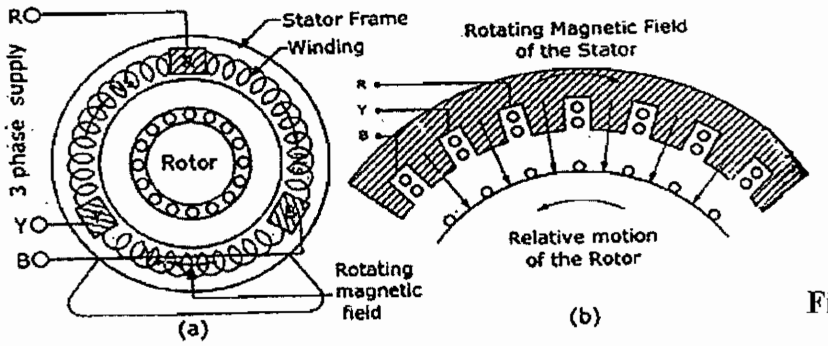


Fig:12.14.

14.2.1. TYPES OF SEMI-CONDUCTORS:

In every elements, the atoms, are tied together by the bending action of valence electrons. Si and Ge atoms contain only 4 valence electrons. These electrons have a tendency to fill the last outermost orbit. In this way, the electrons placed in the last orbit of an atom share the electrons with their neighbouring atoms. Similarly, all electrons are tied together with their neighbouring atoms. For this, they form a band called co-valent bond.

The semi conductors are classified as follows:

Semi-conductors

- Intrinsic Semi conductors
- Extrinsic Semi conductors
  - N.Type Semi-conductors
  - P.Type Semi-conductors.

14.3. INTRINSIC SEMI CONDUCTORS

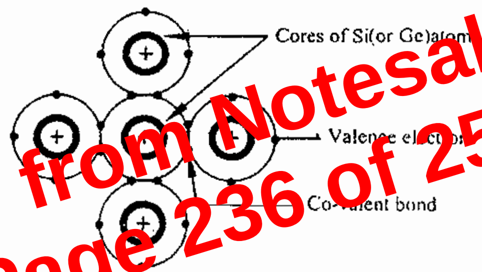


Fig:14.3

A pure semi conductor is called intrinsic semi conductor. The silicon and germanium atoms contains only four electrons in the outermost orbit. So they are called tetravalent atoms. The co-valent band structure of germanium atom is shown in the Fig:14.3.

At low temperature (0 K), the semiconductor behaves as a perfect consulator. Now no electrons get away from the co-valent band. So the current flow (electron flow) is zero. At room temperature, some of the valence electrons may acquire sufficient energy. The bonds may be broken, the electrons become free and are shifted to the conduction band as shown in the Fig:14.4.

14.12. RECTIFIER

Introduction

Mostly all electronic devices require DC power for their proper operations. DC batteries are used for moving vehicles and rarely in commercial appliances, but they are costly and require frequent charging or replacement. So we can get DC power from AC lines by using regulated DC power supply. It consists of transformer, rectifier, filter and regulator.

Classification of Rectifiers

The unidirectional characteristic active element diode is used for this purpose. The rectifier converts an AC signal into DC signal. There are three different types of rectifiers, namely:

a. Half wave rectifier

b. Full wave rectifier

c. Bridge rectifier.

HALFWAVE RECTIFIER

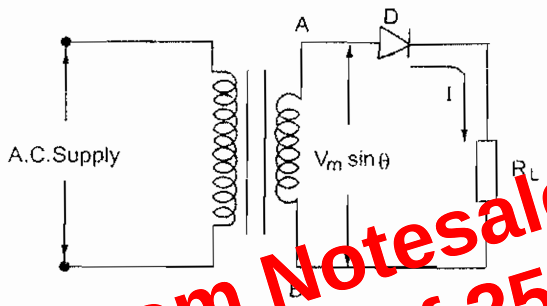


Fig: 14.12

This rectifier converts an AC input voltage into DC pulsating voltage for only one half cycles of the applied voltages. The circuit diagram of a halfwave rectifier is shown in the Fig:14.12. This circuit contains only one diode. So the output contains only positive half cycles of the input.

OPERATION

During the positive half cycles of the input signal, terminal A is positive with respect to terminal B. Now diode D conducts in forwards bias. So the current flows from terminals A to B through diode D and load resistor RL. Hence, input voltage is fully dropped across the load resistor RL.

During the negative half cycles of the input signal, terminal 'B' is positive with respect to terminal A. Now diode D conducts in reverse bias. So no current flows through the diode and load resistor. Now the output voltage is Zero.

In this circuit, the output contains only the positive half cycles of input signed. So it is called half wave rectifier. The input and output waveforms are shown in the Fig:14.13.

In this rectifier, the diode conducts only the positive half cycles of the input signal. So the current flows through the transformer is in only one direction. Hence, DC saturation of the transformer takes place. The peak inverse voltage of the diode should be atleast equal to Vm.