Installation and Maintenance of Electrical Engineering Equipment

Semester-4th

Presented by:-

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DETAILED CONTENTS

1. Tools and Accessories (04 Periods)

Tools, accessories and instruments required for installation, maintenance and repair work. Knowledge of Indian Electricity rules, safety codes, causes and prevention of accidents, artificial respiration of an electrocuted person, workmen's safety devices

2. Installation (18 Periods)

1. Installation of transmission and Distribution Lines:

Erection of steel structures, connecting jumpers, tee-off points, joints and dead ends; crossing of roads, streets, power/telecommunication lines andrailway line crossings, clearances; earthing of transmission lines and guarding, spacing and configuration of conductors: Arrangement for suspension and strain insulators, bird guards, anti-climbing devices and danger plates; sizes of conductor, earthwire and guy wires.

Laying of service lines, earthing, provision of service fuses, installation of energy meters

2. Laying of Underground Cables:

Inspection, storage, transportation and handling of cables, cable handling equipment, cable laying depths and clearances from other services such as: water, sewerage, gas, heating and other mains, and also a series of power and telecommunication cables and coordination with these services, excavation of trenches, direct cable laying, including laying of cable from the drum, laying cable in the trench, taking all measurements and making drawings, back filling of trenches with earth or sand, laying protective layer of bricks etc,) laying of cables into pipes and conduits and within buildings.

3. Elementary idea regarding, inspection and handling of transformers; pole mounted substations, plinth mounted substations, grid substation, busbars, isolators, voltage and current transformers, lightning arrestors, control and relay panels, HT/LT circuit breakers, LT switches, installation of power/distribution transformers, dehydration. Earthing system, fencing of yard, equipment foundations and trenches etc..

2.4 Testing of various electrical equipment such as electrical motor, transformers, cables, and generators, motor control centres, medium voltage distribution panels, power control centres, motor control centres, lighting arrangement, storage, pre-installation checks, connecting and starting, pre-commissioning checks, drying out

3. Maintenance (42 Periods)

1. Types of maintenance, maintenance schedules, procedures

2. Maintenance of Transmission and Distribution System

Authorized persons, danger notice, caution notice, permit to work, arranging of shutdowns personally, temporary earthing, cancellation of permit and restoration of supply.

Patrolling and visual inspection of lines - points to be noted during patrolling from ground; special inspections and night inspections;Location of faults using Meggar, effect of open or loose neutral connections, provision of proper fuses on service lines and their effect on system, causes of dim and flickering lights.

3.3 Maintenance of Distribution Transformers

Transformer maintenance and points to be attended to in respect of various items of equipment

Checking of insulation resistance, transformer oil level and BDV test of oil, measurement of earth resistance

Chapter-1

Tools and Accessories

Chapter-1 (TOOLS AND ACCESSORIES)

INTRODUCTION:- Tools are required to carry out the installation and maintenance work. Without proper tool it is difficult to carry repair and maintenance work.

Various tools used in installation and maintenance and repairing:-

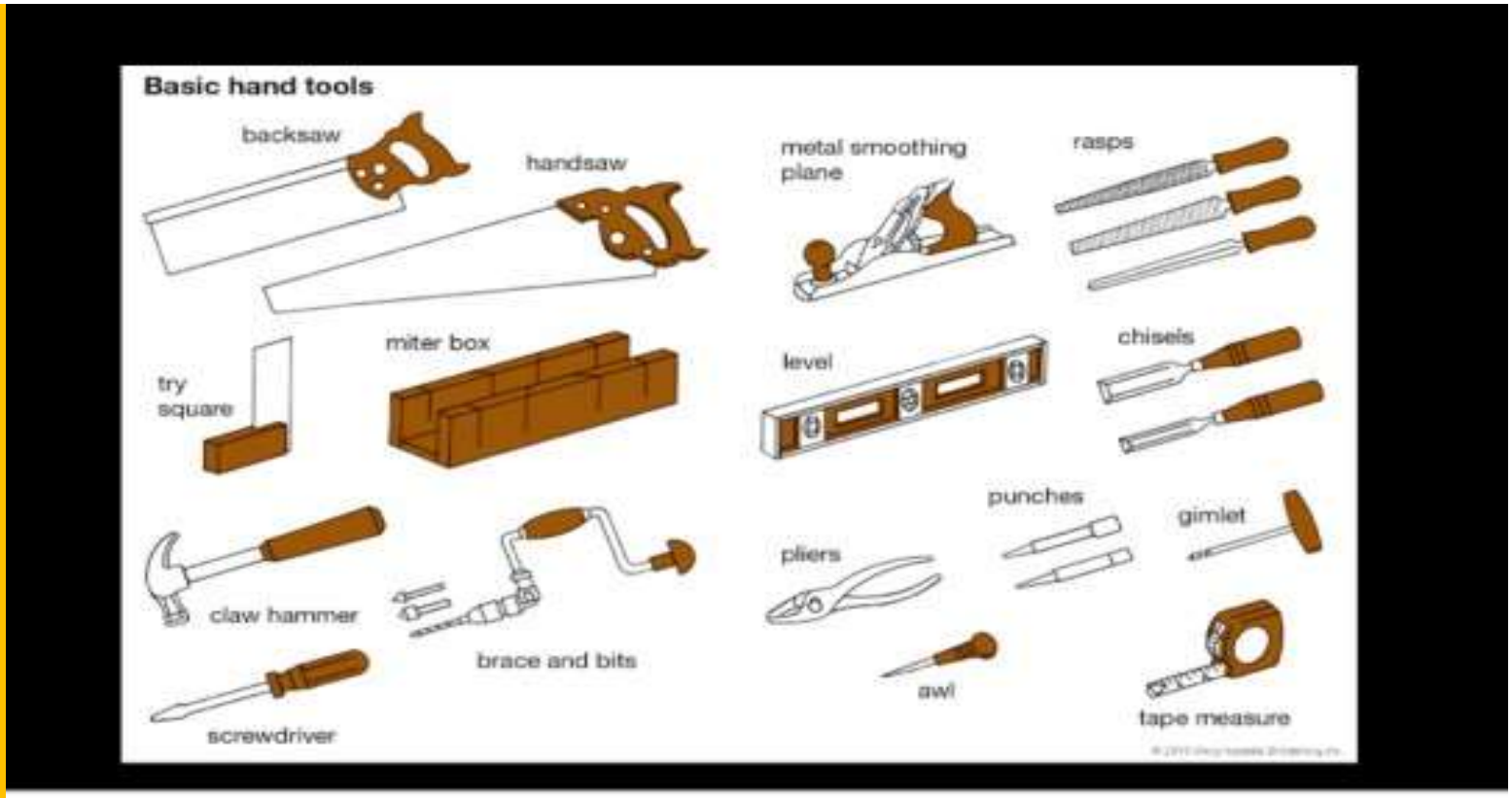
- Combination plier:- Side cutting plier

  Long nose plier
- Screw driver
- Hammer:- Ball peen hammer

  Cross pin hammer

  Claw hammer
- Cutter
- Saws
- Wood saw

- Hack saw
- Knife
- Chisel
- Hand drill
- Files
- Poker
- Gimlet
- Auger bit
- Plumb bob
- Bench vice
- Centre punch
- Spanner
- Standard wire gauge



TESTING AND MEASURING INSTRUMENTS

Earth tester:- Earth tester is used to measure the earth resistance. Earth resistance is special type of ohm meter which send A.c through earth and D.c through the measuring instruments as shown in fig. The value of earth resistance is indicated directly on the scale when handle is turned at uniform speed. The distance between earth electrode and current electrode should be 25m and between potential electrode amd earth electrode it shold be 12.5m.

Value of earth resistance of different systems

Large power station - 0.5ohm

Major sub station - 1 ohm

Small sub station. - 2 ohm

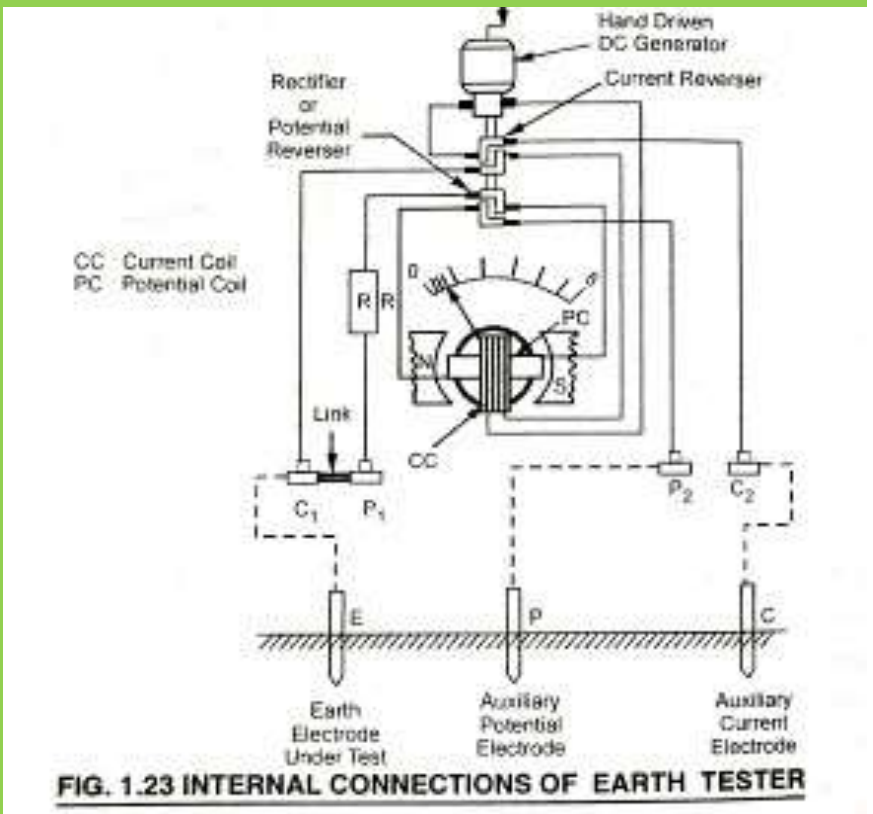


FIG. 1.23 INTERNAL CONNECTIONS OF EARTH TESTER

Meggar :- Meggar is high resistance meter and is used to measure insulation resistance of transformer, generator,motor etc. Available in different voltage that is 500v,1000v,2500v,5000v. A high value of resistance indicates good insulation.

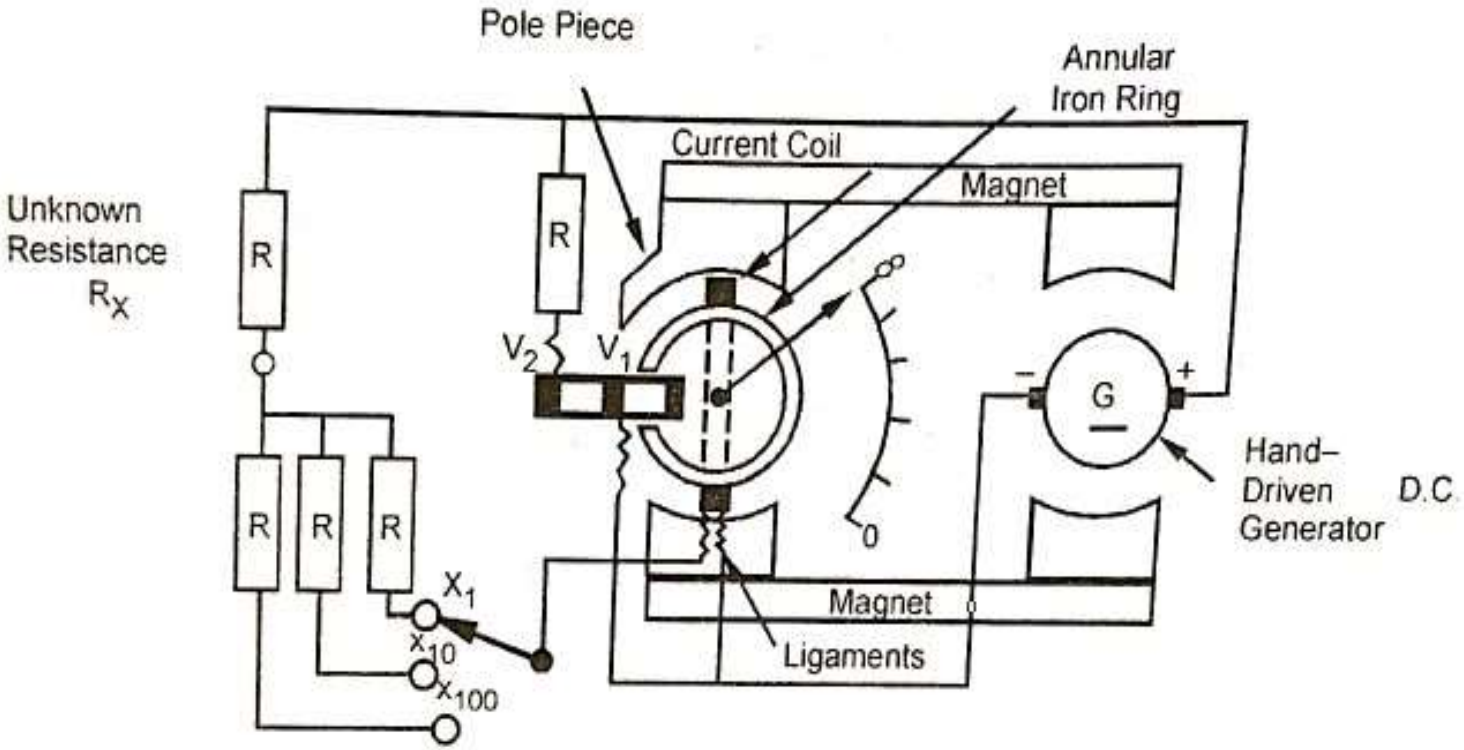


FIG. 1.25 INTERNAL CONNECTION DIAGRAM OF A MEGGER

Phase sequence indicator :- It consist of rotating disc with an arrow marked on it and three terminal RYB.

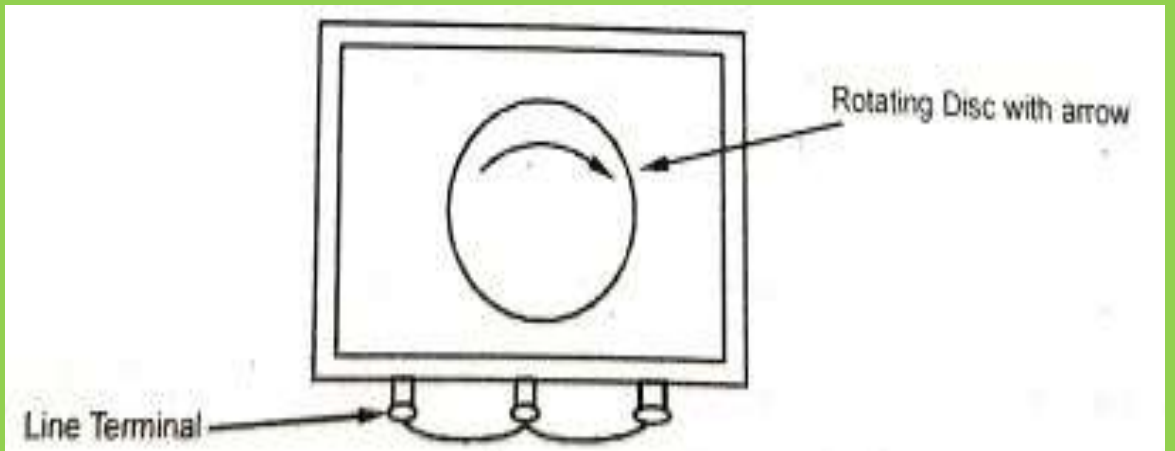


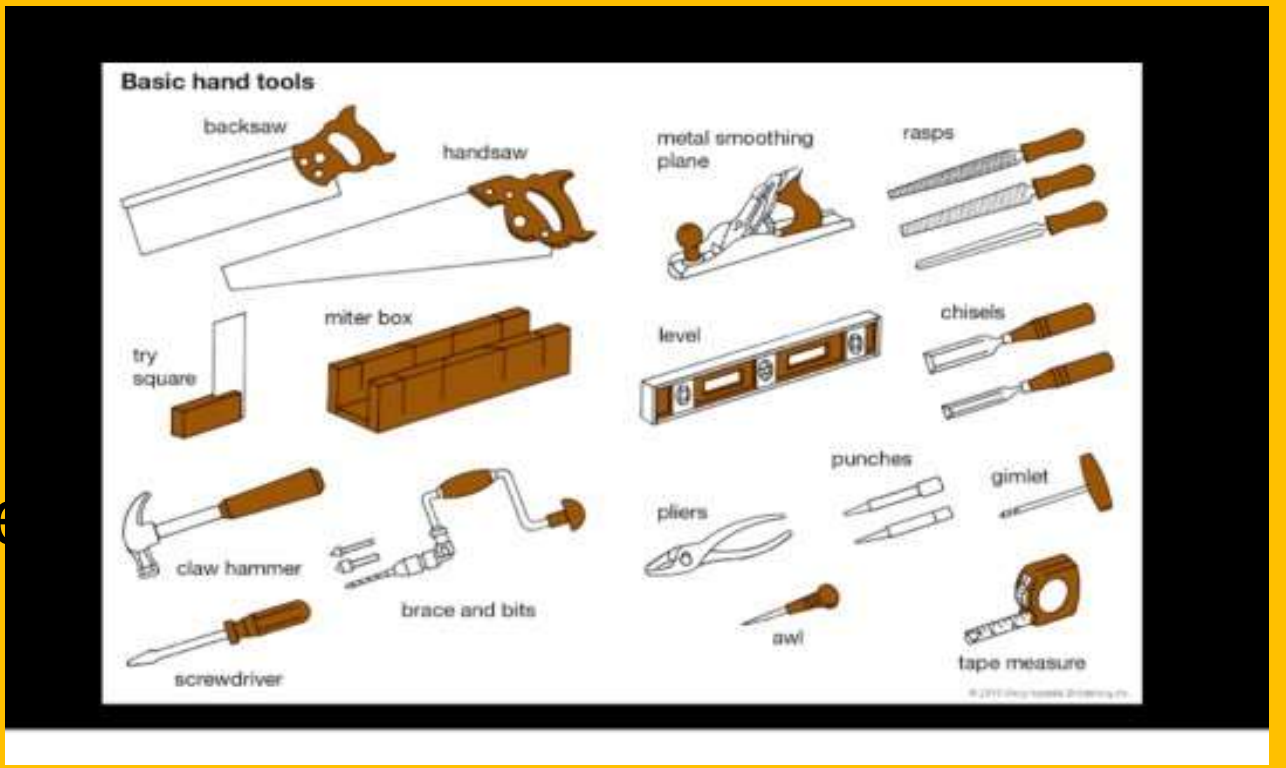
FIG. 1.26 PHASE SEQUENCE INDICATOR

Transformer oil test kit :- It is used to measure the dielectric strength or breakdown value of transformer oil. Details about the test will be discussed in subsequent chapter.

Multimeter :- It is also known as AVO meter that is ammeter, voltmeter and ohmmeter. It is also used to measure AC/DC current and resistance.

Tools and tackles :-

a. Chain pulley
b. Jacks
c. Crane
d. Hammer drill machine
e. Ladder
f. Rubber gloves
g. Helmets
h. Protective cloth
i. Crimping tools e



Electric shock :- It is a sudden stimulation of nervous system of human body by flow of electric current through a part of a body.

Treatment for electric shock :-

1. Switch off the supply
2. Remove the person from direct contact of live wire with wood stick.
3. Remove from the fire
4. Treatment of burns

Artificial respiration

Accident :- It is an unexpected and unplanned event which may or may not injury.

Electrical accidents :- In every case where a person receive an electric shock and suffer injury directly or indirectly incommunication with generation, transmission,distribution and used for electrical energy should be electrical accidents.

Cause of Electrical Accidents :-

1. Working on line wires
2. Unsafe working
3. Lack of supervision
4. Lack of knowledge of electrical instruments
5. Not use proper insulation tools

Artificial respiration :- By following the above points if a person is still not breathing the artificial respiration should be applied immediately to restore the normal breathing and prevent death until the medical aid reaches.

Methods

- Schafer's prone method
- Silvester's method
- Mouth to mouth

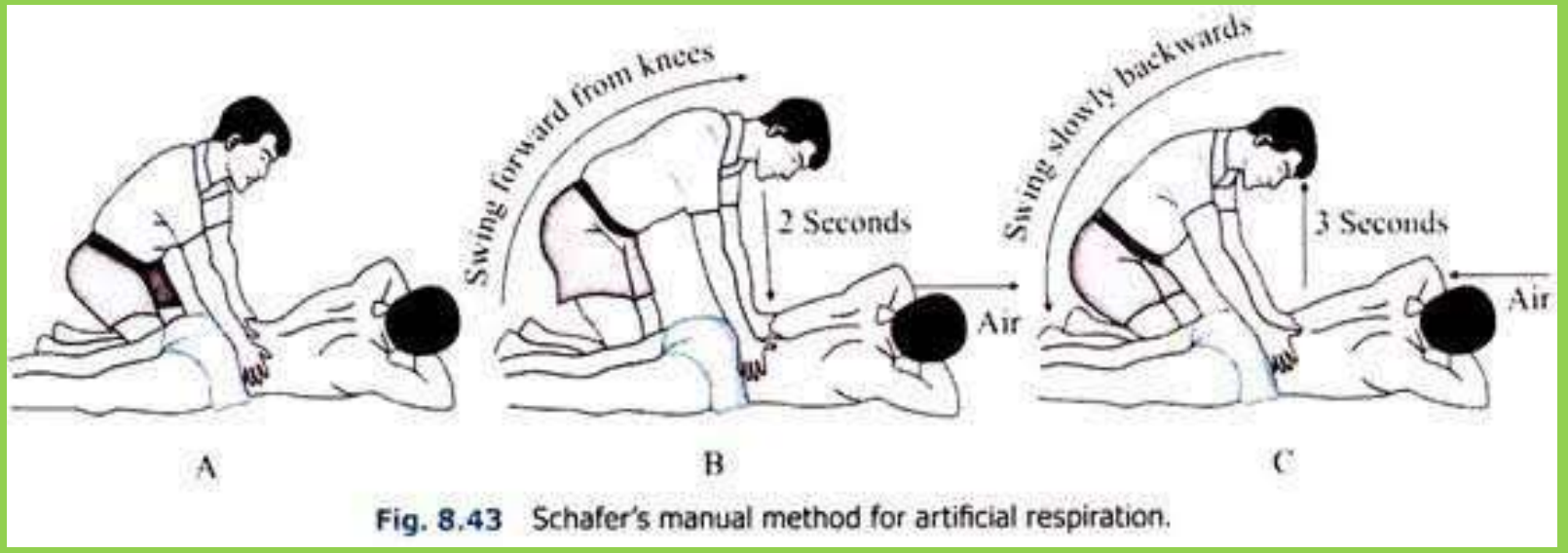


Fig. 8.43 Schafer's manual method for artificial respiration.

Electrical safety rules :-

Indian electricity rules 1956 :- knowledge of this is imporatant for all electrical engineer and supervisors etc.

- Do not use wire with poor insulation.
- Do not tough any electrical equipment with wet hands or bleeding from cut an abrasion.
- Do not work on online circuit without taking extra precautions such as use of rubber gloves, insulated tools like plier, screw driver etc.
- Do not use fire extinguisher on electrical equipment use sand or blanket instead.
- Do not throw water on electrical equipment in case of fire.
- Do not allow to touch the electrical appliance or motor to any unauthorized person or visitors.
- Do not allow to any people in danger zone of HV line
- Do not test the circuit with bare finger

Rule 29 :- Construction, installation, protection, operations and maintenance of electric supply and apparatus.

Rule 30 :- Service line and apparatus on consumer premises.

Rule 35:- Danger Notice

Rule 42:- Accidental charge

Rule 44:- Instructions for restoration of person suffering from electric shock.

Rule 45:- Precautions to be adopted by consumers owner occupies electric contractors electrical work man and suppliers

Rule 47:- Testing of consumer installation

Rule 50:- Supply and use of energy

Rule 51:- Provision applicable to medium high or extra high voltage installation

Rule 56:- sealing of meters and cut-outs

Rule 60:- test for resistance and insulation

Rule 77:- Clearance above ground of the lowest conductors.

Chapter-2

Installation

Chapter - 2 (INSTALLATION TRANSMISSION AND DISTRIBUTION LINE)

Transmission system:- An arrangement of substation transmission line and intermediate substation associated control, protection observe etc are known as transmission system.

Transmission line:- The transmission of electrical power or eneiis done through wire supported on towers are called transmission line.

Distribution system:- The system which which receives the bulk power from the transmission system at the receiving stations(66kv,132kv,220kv,400kv) and distribute it to various consumers at reduced voltage level i.e 440v 3- phase/230v single phase is known as distribution system.

Installation:- It is the process of installing the machinery/ eauipment/transmission line etc. On foundation at site along with accessories to make the equipment plant ready for testing and commissioning.

Testing:- After installing the equipment testing is carried on equipment and its sub-system to ensure safe and proper performance as per the the specification of the equipments.

Commissioning:- It is done after the testing of equipment is over.

Classification of Voltages:-

Low voltage - below 1000

medium voltage - between 1000v and 33kv

high voltage - above 33kv

Extra high voltage - above 220kv

Ultra high voltage - above 750kv

Classification of Lines:-

Short line - 80 km

Medium line - 80 km - 160km

Long line - above 160km

Planning in Route of lines:-

- The proposed route of the line should be shortest practicable distance and as straight as possible.
- If possible the lines should be run along the roadway or railway
- Bridges,industries,religious place,water logged areas, garden,tress should be avioded as far as practicable.
- The line should be away from bulk storage of oil tanks, oil or gas pipelines.
- Line should be away from telecommunication line.

Components of Transmission line

a. Conductors
b. Supports and cross arms
c. Insulators
d. Pole fitting
e. Stay wire
f. Miscellaneous items

Conductors:- The conductors are used for transmission and distribution of electrical power from generating station to sub station and from sub station to consumers premises.

Properties:-

- High Electrical conductivity
- High tensile strength
- Easily available
- Light in weight
- Low cost

Types of conducors:-

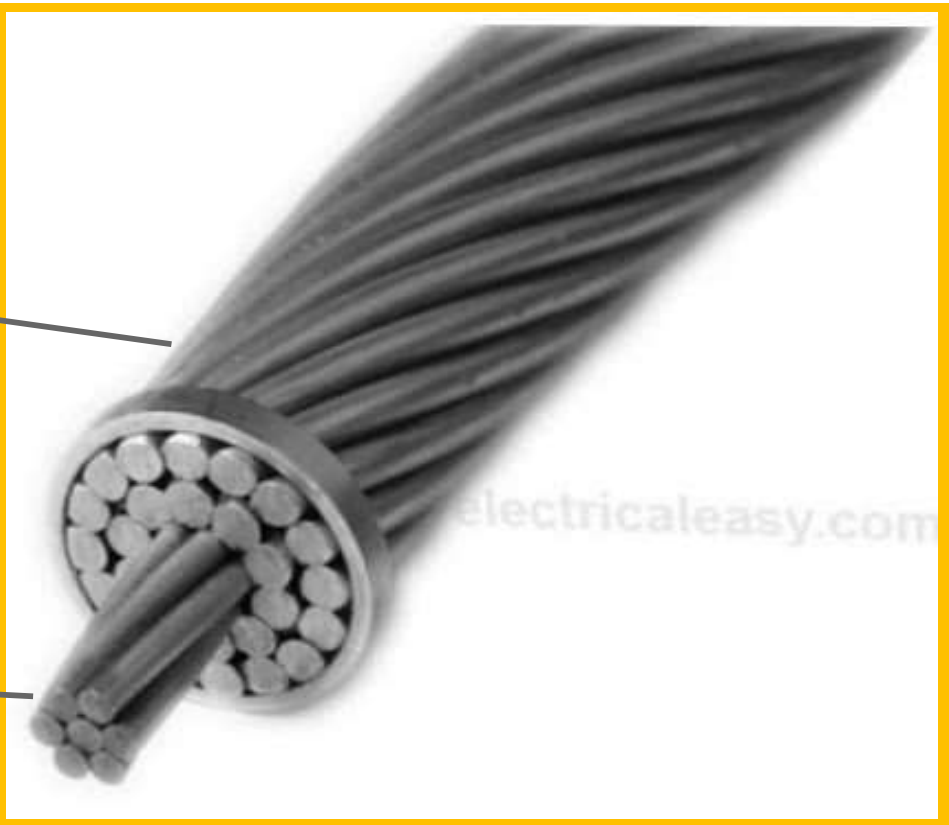
a. Copper
b. Aluminium
c. A.C.S.R

Copper:-Copper has a high conductivity and greater tensile strength. So, copper in hard drawn stranded form is a great option for overhead lines.

Aluminium:- Aluminium has about 60% of the conductivity of copper; that means, for the same resistance.Also, tensile strength of aluminium is less than that of copper. Considering combined factors of cost, conductivity, tensile strength, weight etc., aluminium has an edge over copper. Therefore, aluminium is being widely used for overhead conductors. Cheap in cost.

A.C.S.R:- ACSR consists of a solid or stranded steel core with one or more layers of high purity aluminium (aluminium 1350) wires wrapped in spiral. The core wires may be zinc coated (galvanized) steel or aluminium coated (aluminized) steel. Galvanization or aluminization coatings are thin and are applied to protect the steel from corrosion. The central steel core provides additional mechanical strength and

Aluminium wire



Steel wire

hence, sag is significantly less than all other aluminium conductors.

Line support

The support for transmission and distribution lines are poles and towers.

Properties:-

- High mechanical strength
- Light in weight
- Longer life
- Cheap in cost
- Low maintenance cost
- Easily accessible for paint

Types of line supports

1. Wooden pole
2. Steel pole
3. R.C.C poles
4. Steel pole

Wooden poles:- It is one of the cheapest types of line supports and used for lines where spans are short, and tension is low. The wood poles have the limitations of height and diameter. It is two types A or H. Height is 10 to 12 mtr. These are embedded in ground depth of 1/6th of height of pole in case normal soil and 1/5th of poor case soil. Life of this pole is 25 yrs.

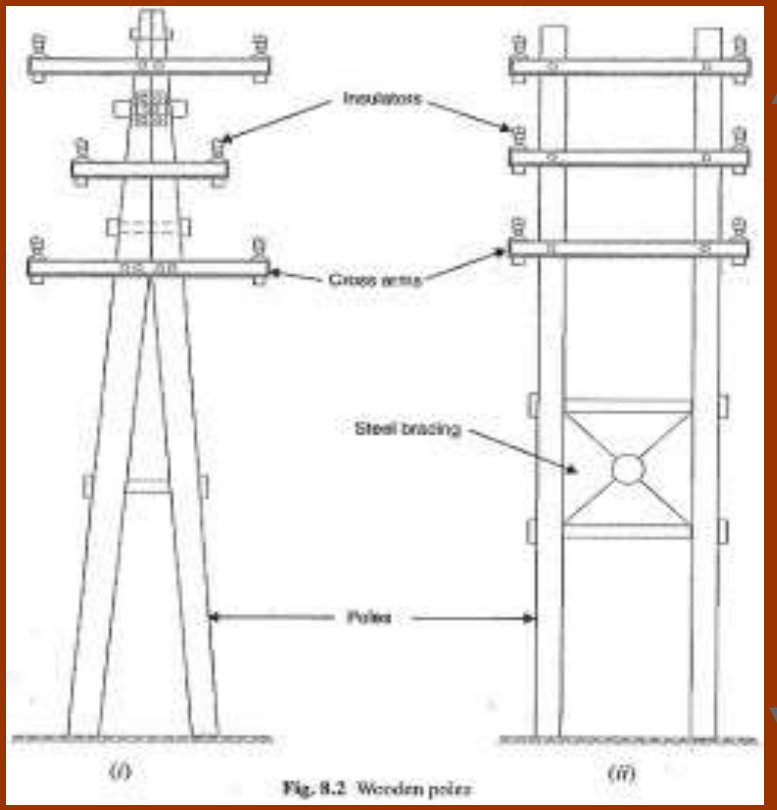
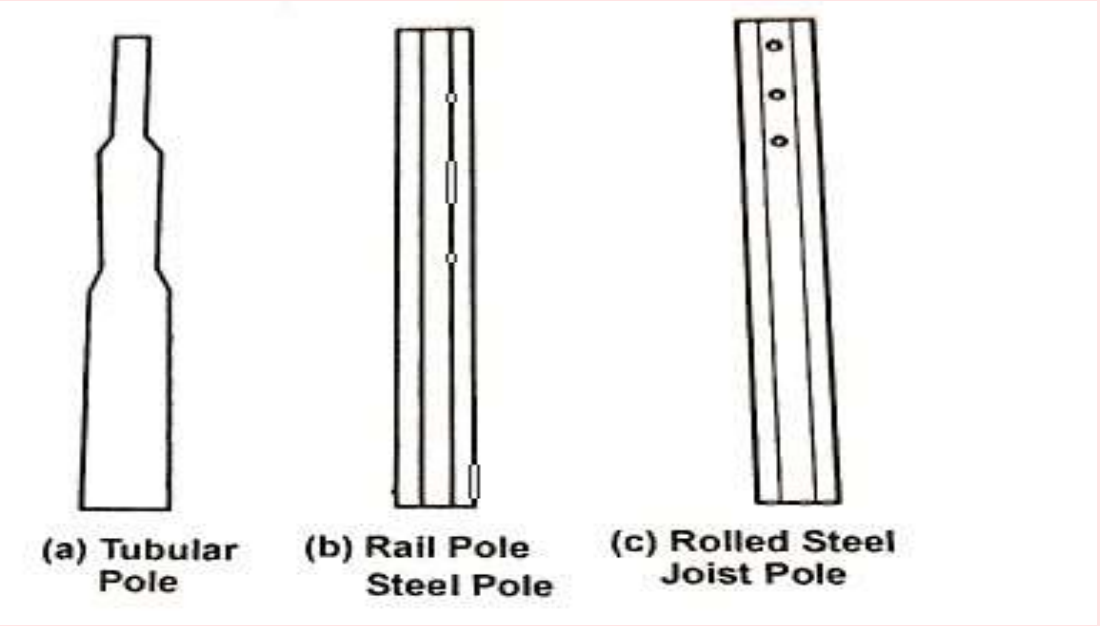


Fig. 8.2 Wooden poles

Steel pole:- These poles have more strength as compared to wooden poles.For low and medium voltage tubular steel poles or Grider steel supports are used. Longer spans are possible with steel poles. The poles need to be galvanised or painted periodically to prevent them from corrosion. Their maintenance expense is high.



Life of this pole 40 yrs.

R.C.C pole:- Reinforced cement concrete. These pole are used upto 33 kv line. They have replaced the wooden and steel pole due to its longer life free from insects and atmospheric effect. The life of this pole is very long.

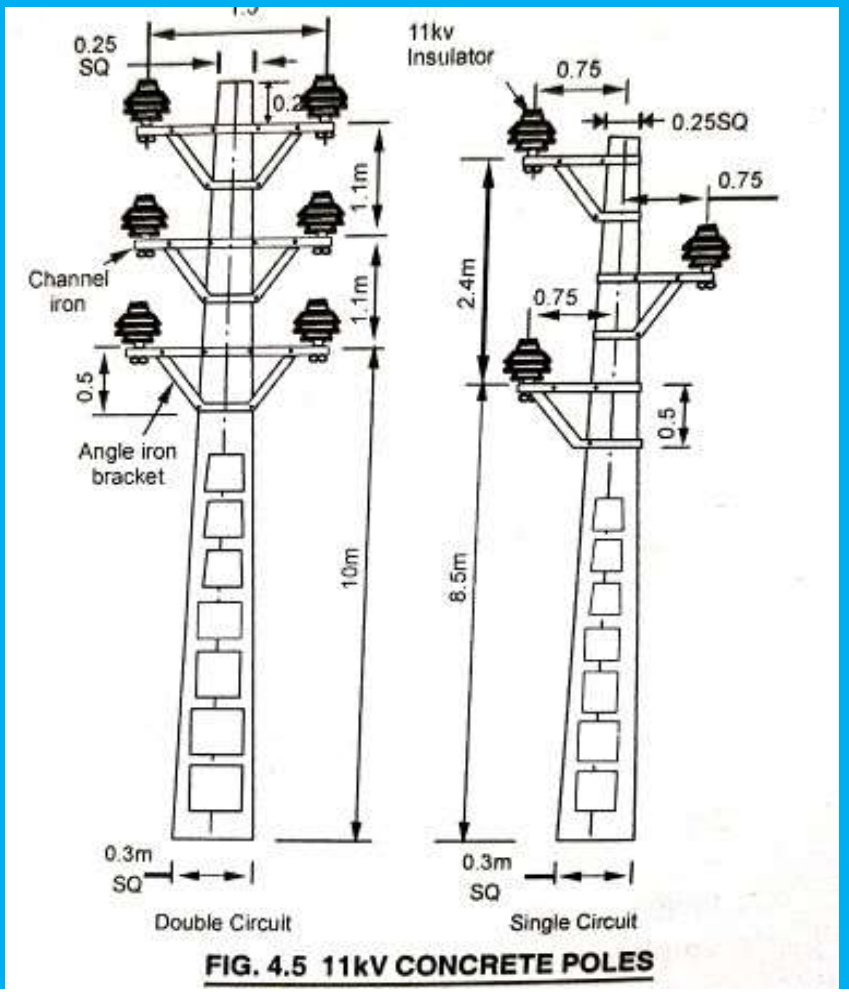


FIG. 4.5 11kV CONCRETE POLES

Steel tower:- These are used for long distance transmission line at higher voltage. These are most strong and rigid. The tower are filled in concrete base called concrete muffs.

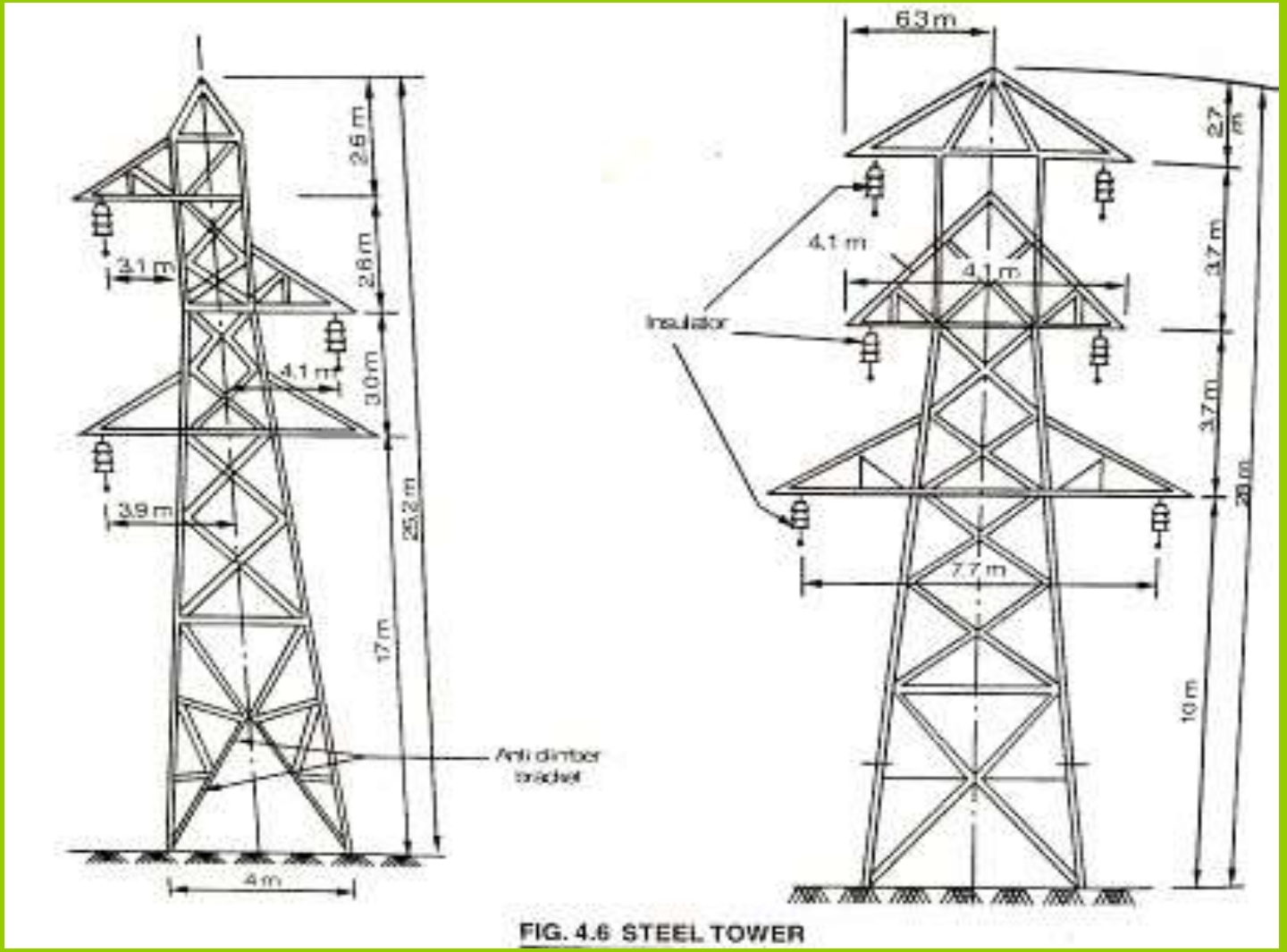


FIG. 4.6 STEEL TOWER

Spans for poles and tower:-

Wooden and steel pole:- 30m to 50m as a distribution poles in residential areas. Longer spans 50m to 80m are used in rural areas. R.C.C poles spans are 80m to 200m.

Steel tower:- The height of steel tower varies from 20m to 45m and span of 200m to 400m are used. For railway and river crossing long span upto 800m are employed.

Erection of pole and steel structures:-

Once the collection amd transportation of material about poles is completed the next- step is to start the pole foundation excavation work and then erect the pole.

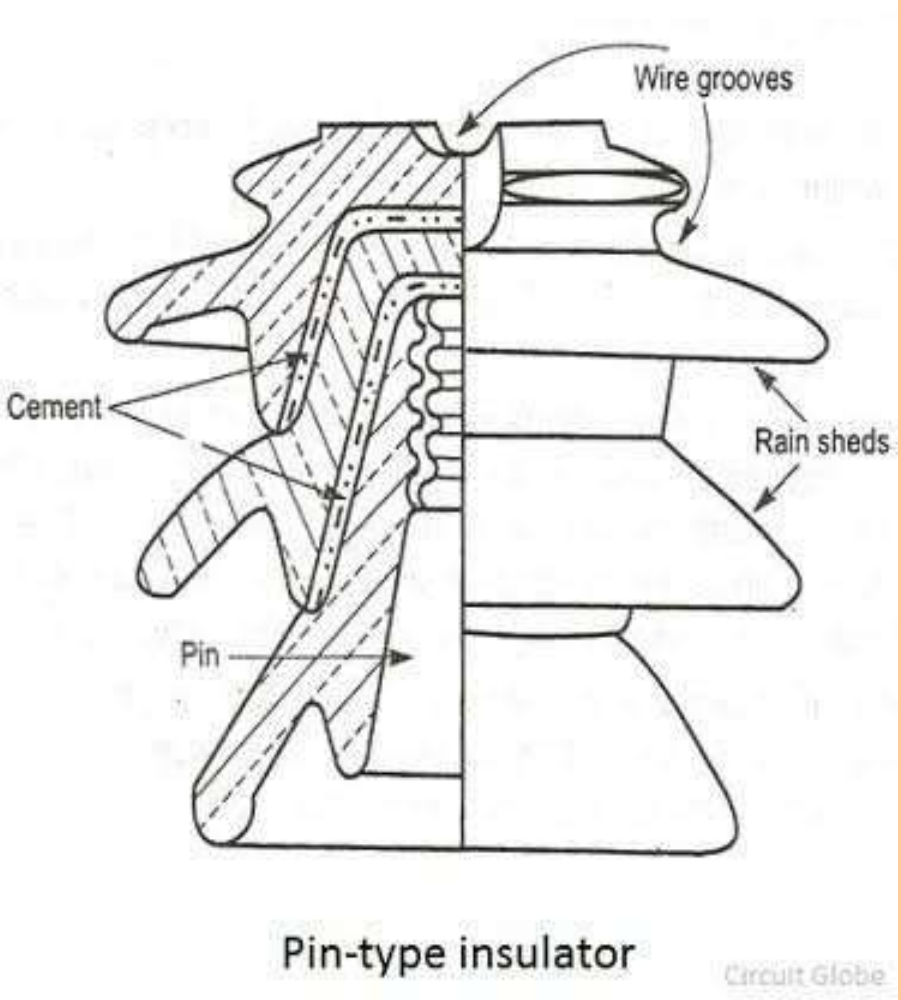
1. Dead man method
2. Derrick pole method

Insulator:- The overhead line conductors are supported by mean of insulating fixtures called the insulators. The insulator are made up of porcelain,glass or steatite.

Types:-

a. Pin type insulator
b. Shackle type insulator
c. Suspension type insulator
d. Egg type insulator

Pin type insulator:- used for 33kv line. These are economical simple and easy to install. These type of insulator carry the conductors at the top.



Shackle type insulator:- used for low voltage distribution lines. These are used at the starting and last end poles or turning end poles.

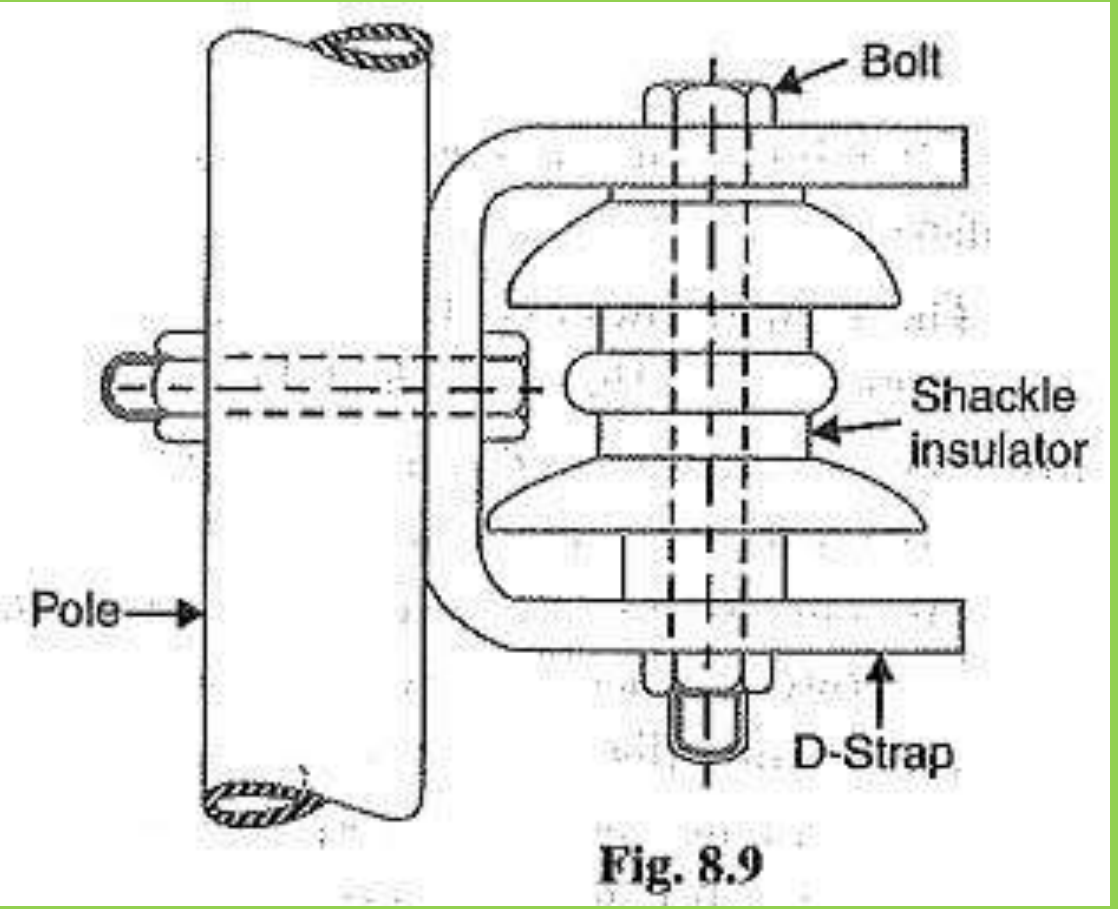
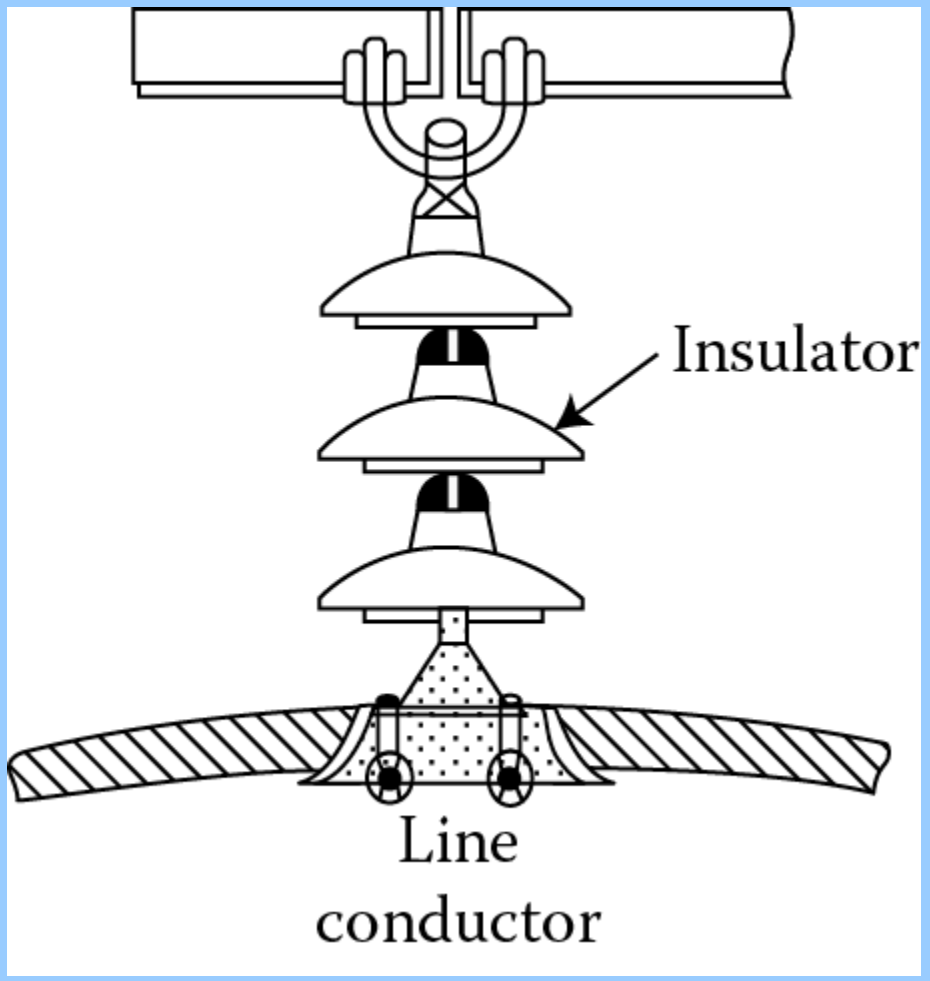


Fig. 8.9

Suspension type insulator:- It is used for high voltage transmission. This insulator consist a number of similar disc sus-pended from the tower amd hold the conductors at bottom.



Egg type insulator:- It is used for support the pole. These insulators provide the insulation between between pole and lower parrt of stay wire for the safety of people and animal on the ground. These provide at a height of about 3m from the ground level.

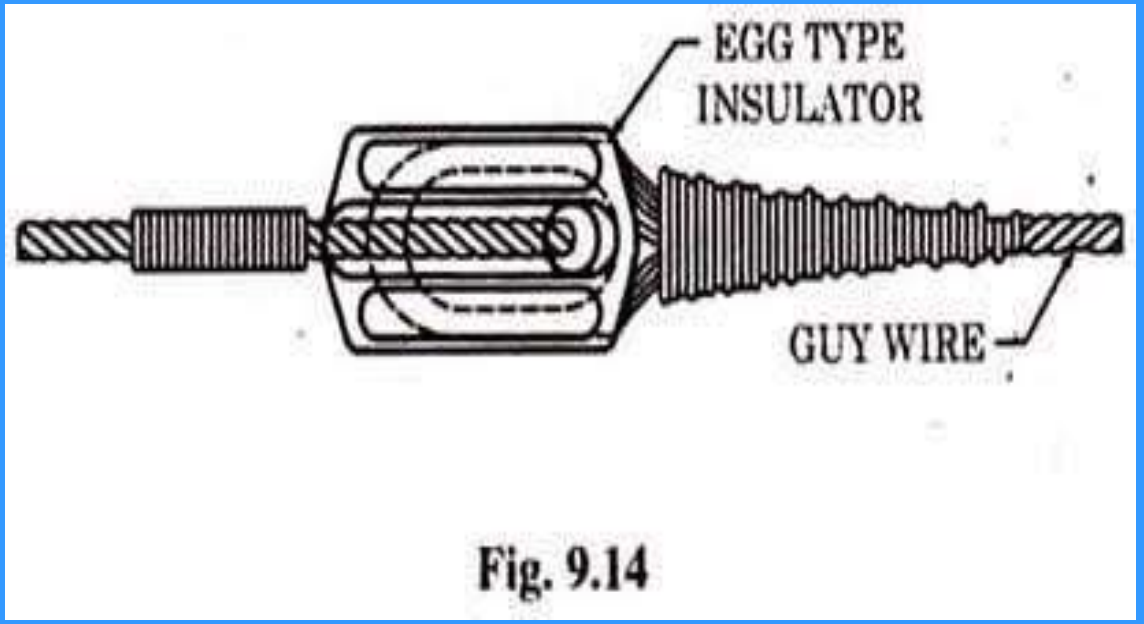
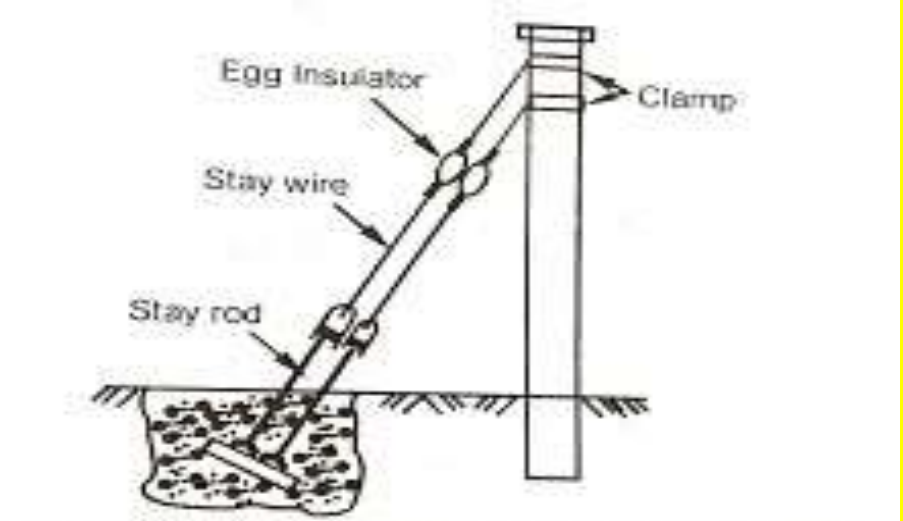


Fig. 9.14

Cross-arms:- Cross arm are used to support on the poles. These are made of eíther wóód or iron. These are fixed at the top portion of the pole.

Stay wire and guy wire:- It is necessary to support overhead line pole when conductor run at angles and terminal position so that the pull or tesnsion created by conductors is balanced stay wire is also known as guy wire.



Single Stay Arrangement with no Space Available For Laying Stay Rod

Miscellaneous items

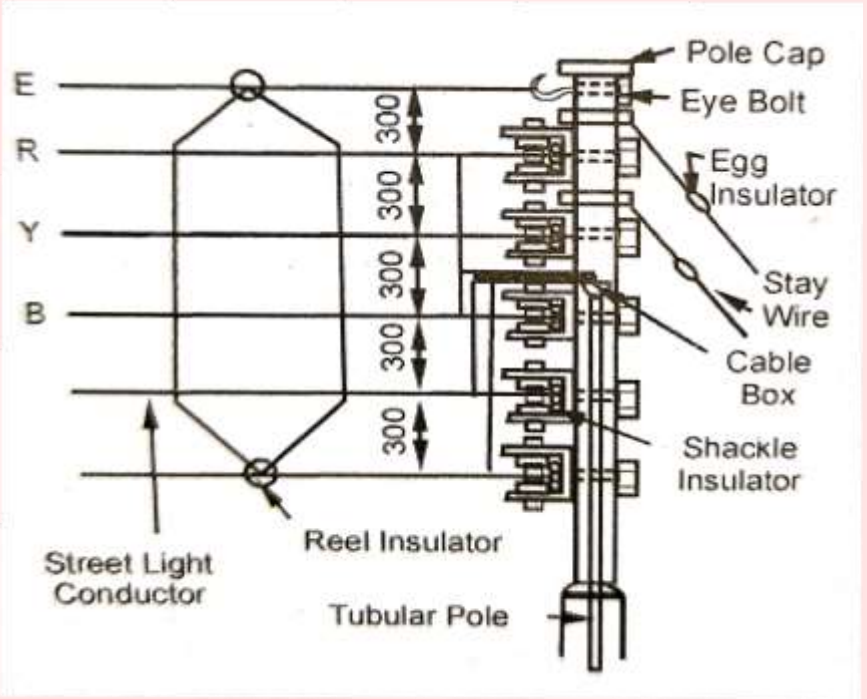
Lightning arrestors:- A lightning arrestors provide a path through air gap for electric current between electric circuit and the earth at the time of excessive voltage caused by lightning.

Guarding of over head lines:- I.E rules 87 and 88 provide important guidelines about guarding of overhead lines. Gurading is generally done to prevent the falling of live wire on the ground.

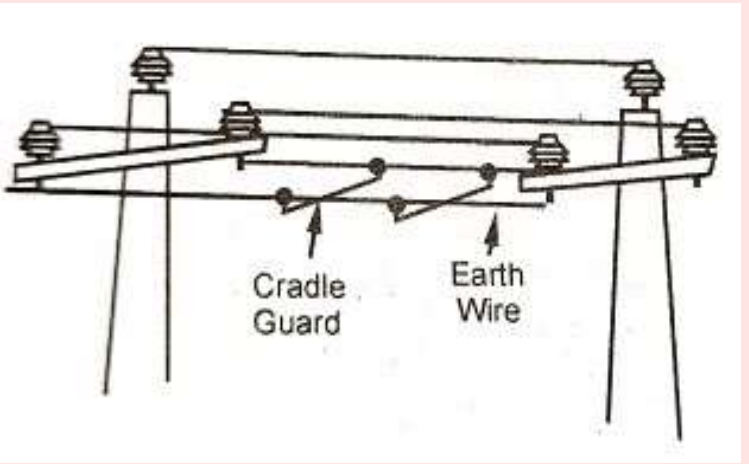
Types:-

1. Cage guarding
2. Cradle gurading
3. Bird guarding

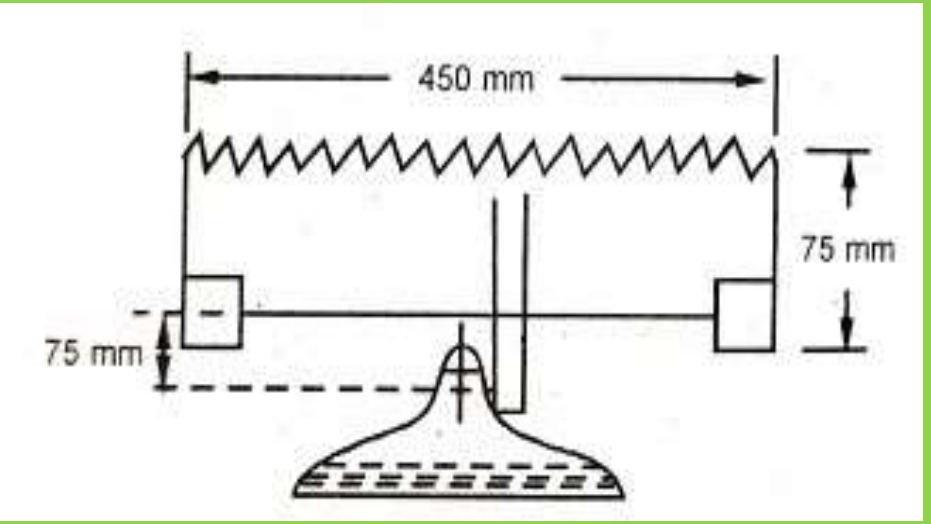
Cage gurading:- It provide on L.T lines when the conductors are in vertical configuration.



Cradle gurading:- it is provided when the conductors are in horizontal formation.



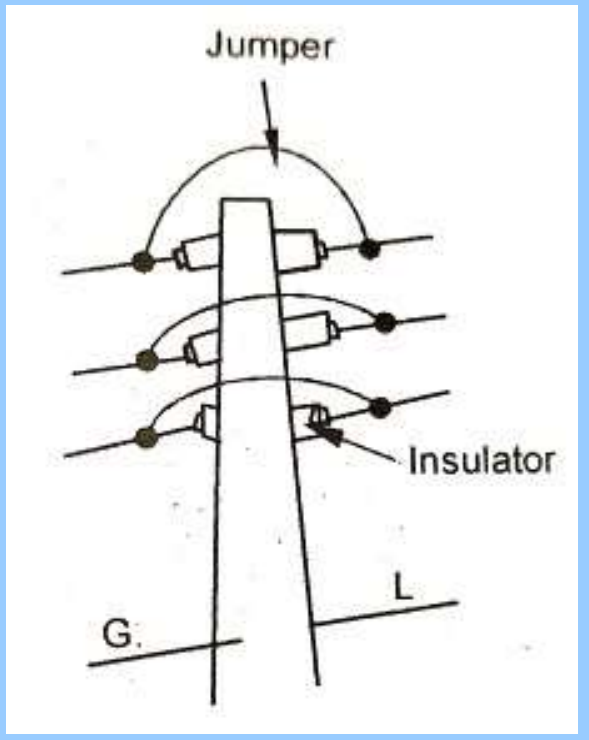
Bird guarding:- To prevent the fault condition caused due to the bird come in contact with the high tension line bird are fixed ovér the suspension isulator strings in the saw tooth form



Anti-climbing device:- A wire which is wrapped on a pole at a height about 2.5m from the ground atleast 1m length is called barbed wire.

Danger plate:- Danger notice mean a notice attached ti live electrical apparatus calling attention to the danger of touching such apparatus.

Jumper:- A short length of conductor which is used to used to connect the line conductor on one side of the terminal pole to the line conductor on the other side of the pole is known as jumper. It is made of the same materialas of the same material as of the line conductor. A suitable clamp is needed to fire



the jumper to the line conductor.

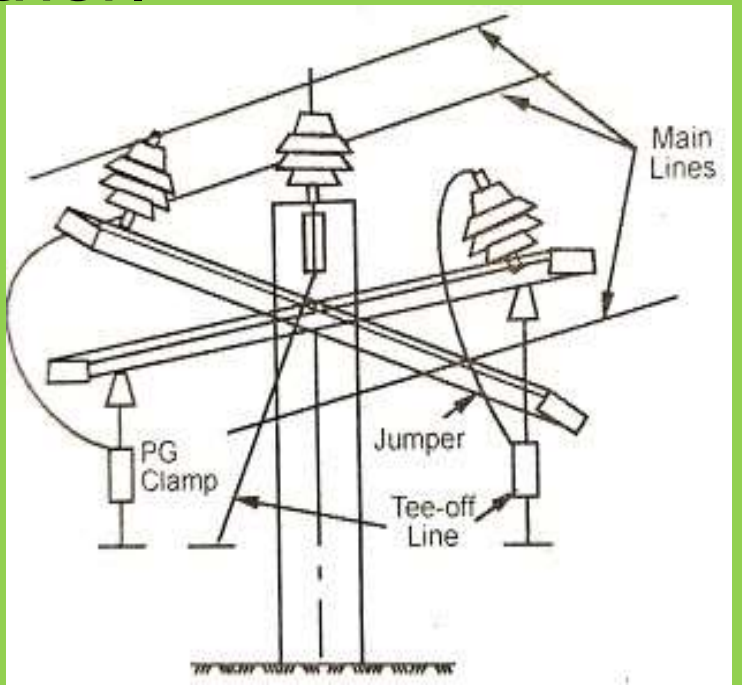
Tee-off:- Tee off should be taken from the pole not from the centre of the line. It should be done in same manner as in case of jumpers. Tee off for two different conducotrs that is one for main line and other for tee off line should not be done directly a special connector such as tee connectors.

Types of tee arrangement:-

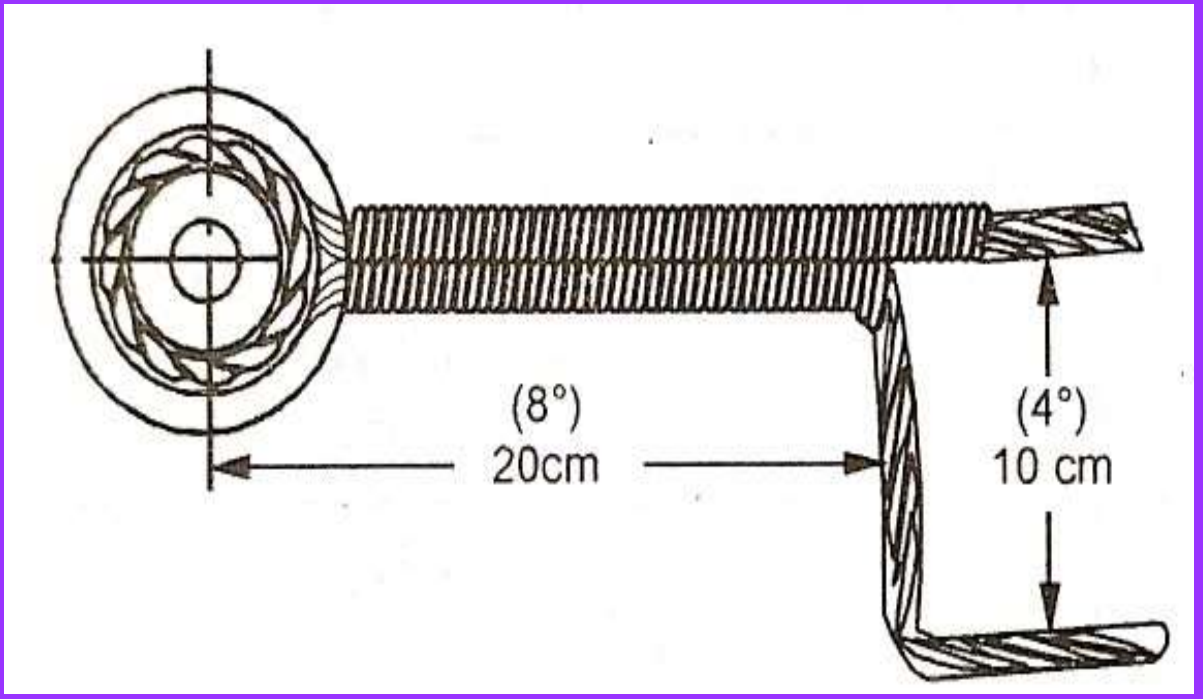
Single pole tee arrangement

H- pole tee arrangement

Parallel grove clamp:- A clamp or connectors which is used for the purpose of connecting of two or more conductors of similar material and whose axes are parallel of each other.



Dead end:- During distribution and transmission systemthe situation comes when conductors are required to he dead ended at several cases specially at places where line takes a turn and line conductor terminates.



Right of way

The land require for AC transmission line is called right of way.

Pole line

It require 7.5m to 15m in single ckt. In pole line

It require 9m to 22.5m in double ckt in pole line

Tower line

It requires 9m to 18m in single ckt in tower line

It requires 12m to 22.5m in double ckt in tower line

Size of conductors:-

The different material such as copper aluminium are used to carry the current from one place to to another place is called conductors.

Factor on conductor size depend:-

- Minimum size of conductors
- Current carrying capacity
- Voltage drop

Strength of material

Spacing and configuration:-

Conductors spacing:- spacing between the conductors should be reasonable.

Spacing should be neither be large and nor be less.

$$\text{Spacing} = \sqrt{S} + V/150m$$

S- sag in meter

V- line voltage in kv

Conductors configuration:-

The meaning of conductor configuration is an arrangement of the conductors on line suppport. It is based on nber of the conductors to supported. It os commonly used three types:-

a. Horizontal configuration
b. Vertical configuration
c. Triangular configuration

Clearance of conductor

Ground and lowest conductor rule 77 of I.E 78,79.

- Repairing and jointing of sleeve

Repairing:-

As we know that the ACSR are conductors are generally used for transmitting the electrical energy from generating station to substation due to passage of time or other atmospheric condition surface of these conductor may damage is causing aluminium strands broken or damaged badly. when damage of this conductors are less than repair sleeves may be employed for repairing of a ACSR conductor but when this damage is more than it is better to cut the conductor and join it with the help of jointing sleeve.

Jointing:-

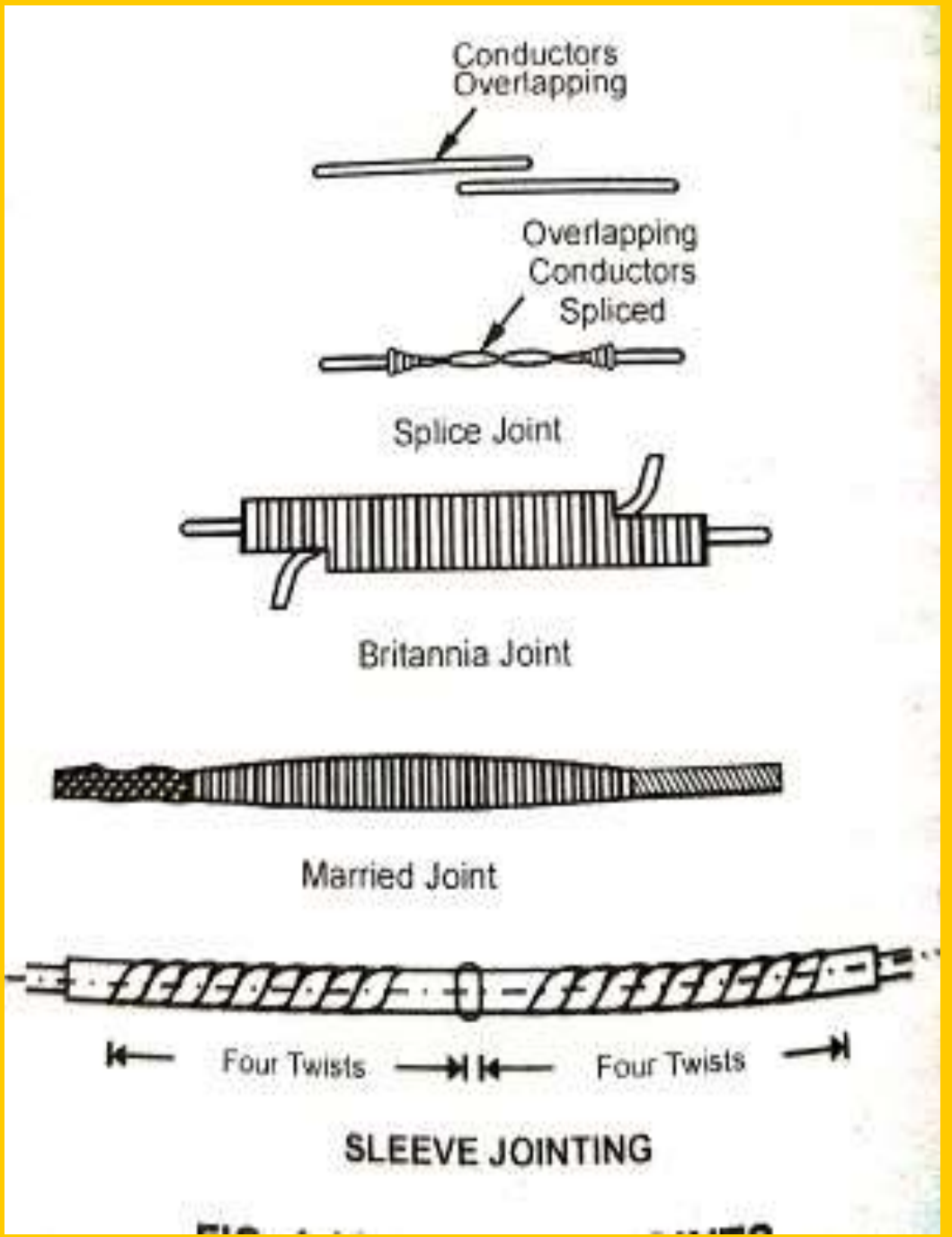
It is not possible to use single length of conductor for full length of transmission and distribution line therefore jointing of conductor essential.

A good joint should have the following qualities:-

- It should have some conductivity as as of conductor used
- Joint must be able to withstand maximum for current without failure
- Mechanical strength should not be less than 95% of breaking load of the conductor
- It should have a trouble-free long life it should be simple indesign

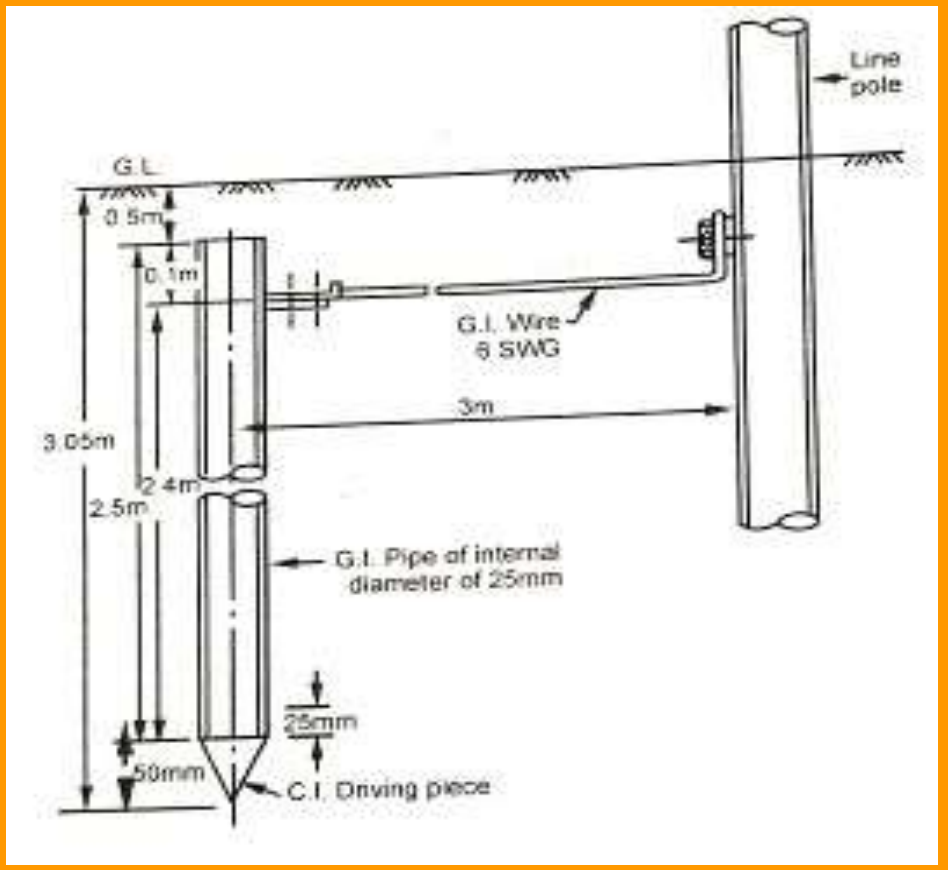
Types of joints:-

a. Splice joint
b. Britannia joints
c. Married joint
d. Sleeve joints
e. Compression joint



Earth wire:-

A wire made of galvanized steel used to connect the non current carrying metal parts used in transmission and distribution line to the general mass of earth is known as earth wire. The size of earth wire for distribution line is G.I no. 6 swg.



Service line or connection:-

The overhead line or cable connection taken from the nearest pole of the line to the consumer premises called service line. The voltage is step down from 11KV to 440 volt in service line by using transformer service line is the last line of transmission and distribution system of electrical power from generation to consumer premises.

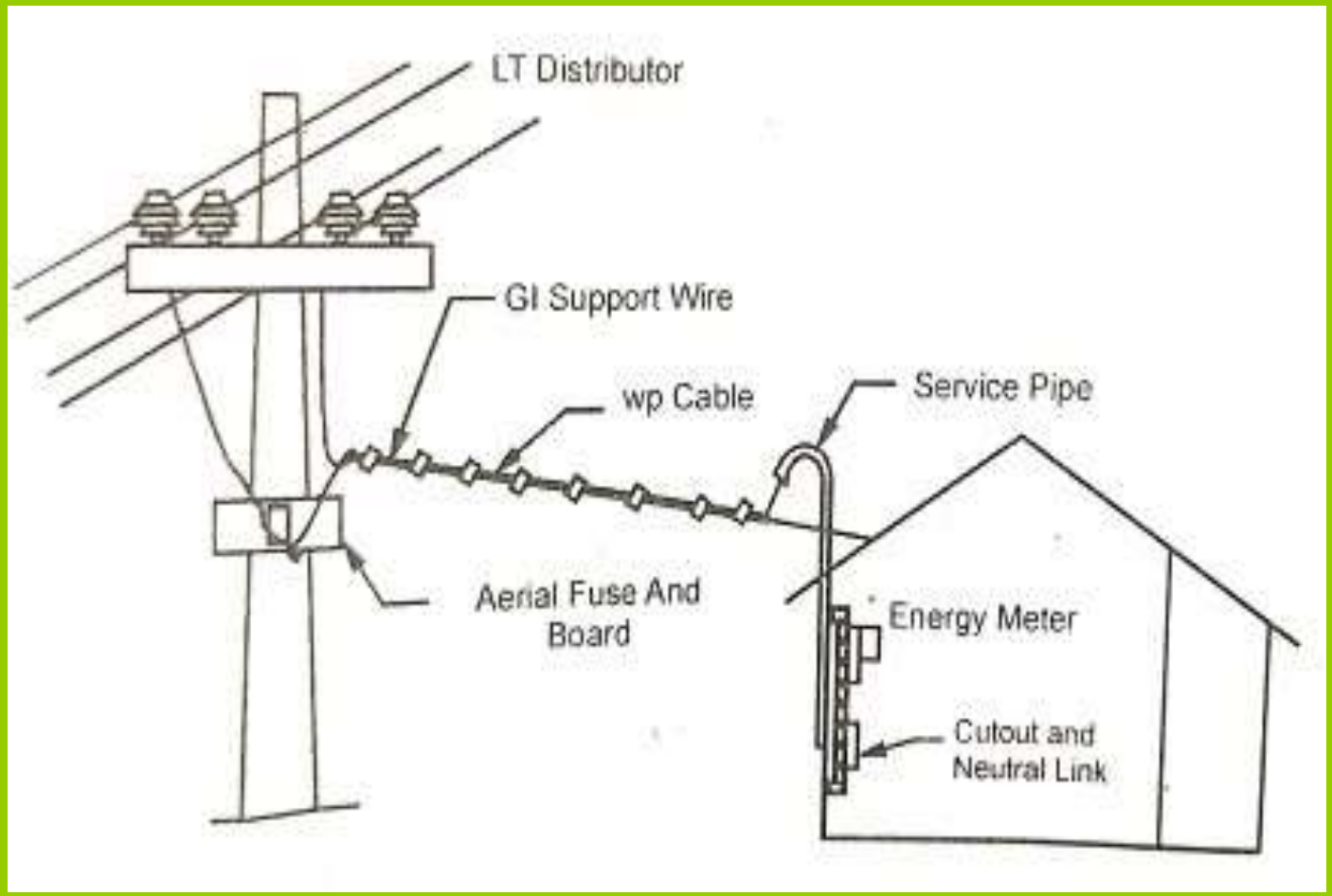
Service board:- The board on which cutout neutral link and energy metre are installed is called energy board of service board.

Types of laying service line:-

Overhead service connection

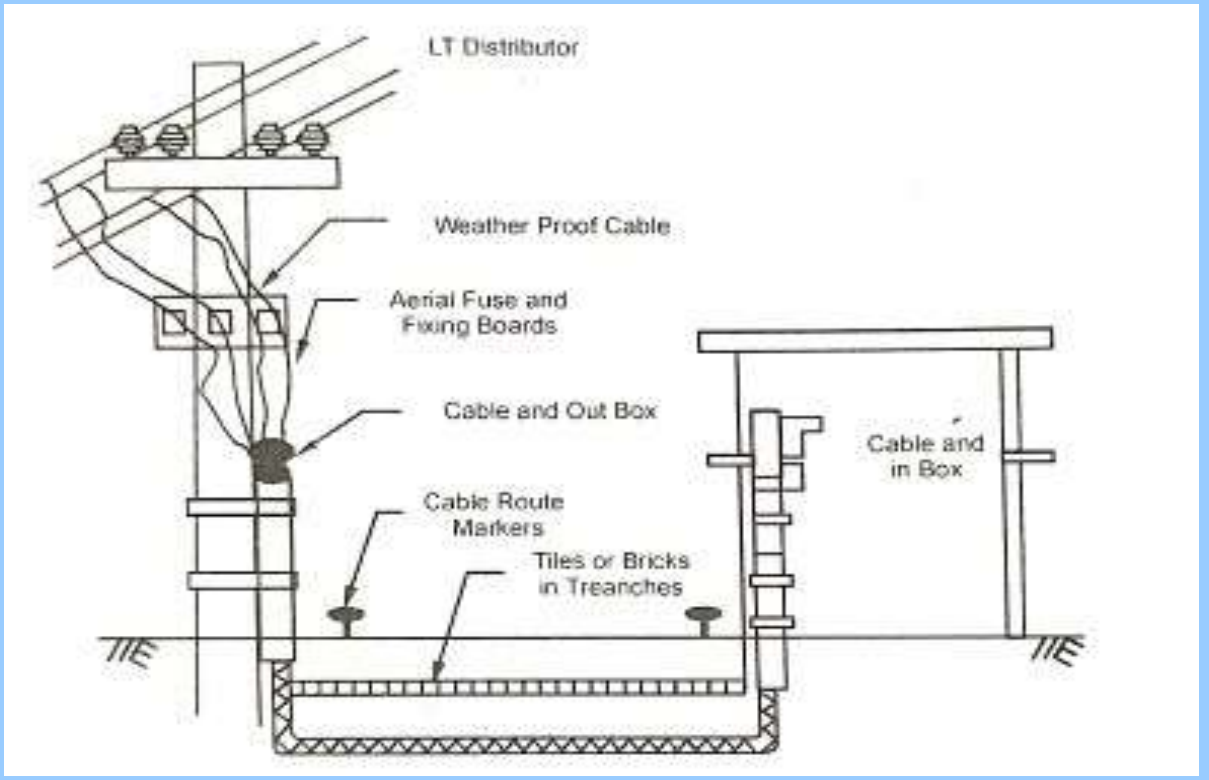
Underground service connection

Overhead service lines:- I.E rules number 58 77 and 79 must be regulated while laying of the overhead service connection.



Underground service connection:-

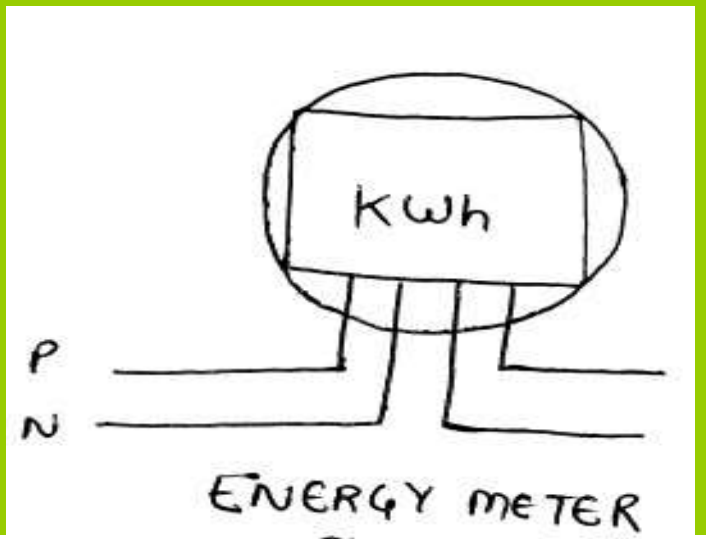
For background service connection cable box is fixed at the service pole by mild steel channel of size 16mm*25mm with bolts and nuts. 0this cable is carried from cable box of the cable box fitted on the service board.



Installation of energy meter:-

Energy:- It may be defined as work or dissipation of heat over an interval of time.

Energy meter:- Energy meter are the integrating instrument used for measurement of energy consumed in a circuit over a given interval of time. The energy metre is a selected as per load of the consumer etc. energy metre install on wooden board and these wooden boards are fixed on the wall at suitable height from the ground. Energy metre should be installed in the consumer premises and the next to the cutouts if used in service line.



Laying of underground cables:-

Cable:- A single conductor insulated through its full length is called cable.

Underground cable:- Two or more conductor is provided with its installation and laid up together under one out a protective covering is known as underground cable.

Core:- A single core cable has one conductor and three phase cable has three conductor core in a conductor.

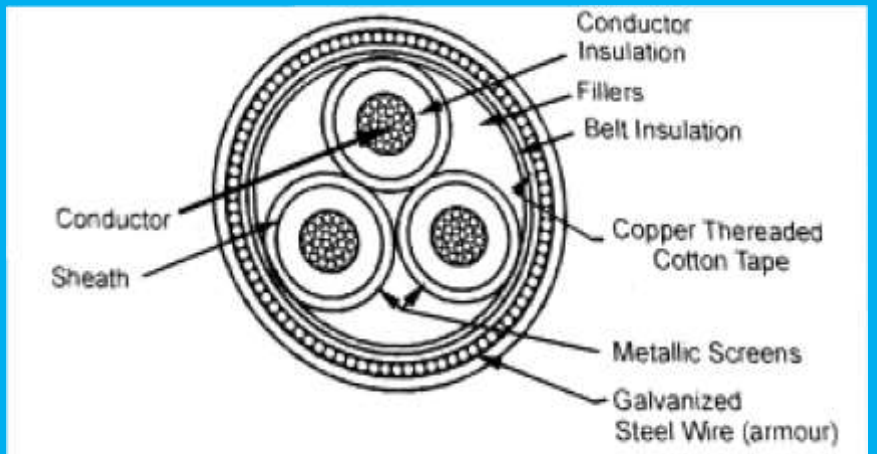


FIG. 4.22 THREE-CORE CABLE

Sheath:- Metallic aur non metallic protective covering over the conductor insulation and shield extra it is called as a jacket or covering.

Insulation:- Each conductor or core is covered by an insulation.

Armour:- Outer most protective layer for protection against soils,chemical,moisture and water extra.

Advantage of underground system:-

- It has a long life
- underground system installed in uninterrupted continuity of supply
- Require less maintenance
- 8 altimate hazards of electrocution due to breakage of overhead conductor
- Appearance in overhead system is not pleasant.

Classification of cables:-

Cables are classified on the basis of voltage:

Low tension cable - voltage upto 1000v

High tension cable - voltage rating 1000v to 11000v

Super tension cable - voltage upto 33kv

Extra high tension cable- voltage upto 66kv

Oil filled cables and gas filled

pressurized cables - voltage upto 132kv

Extra super tension cable - beyond voltage rating 132kv

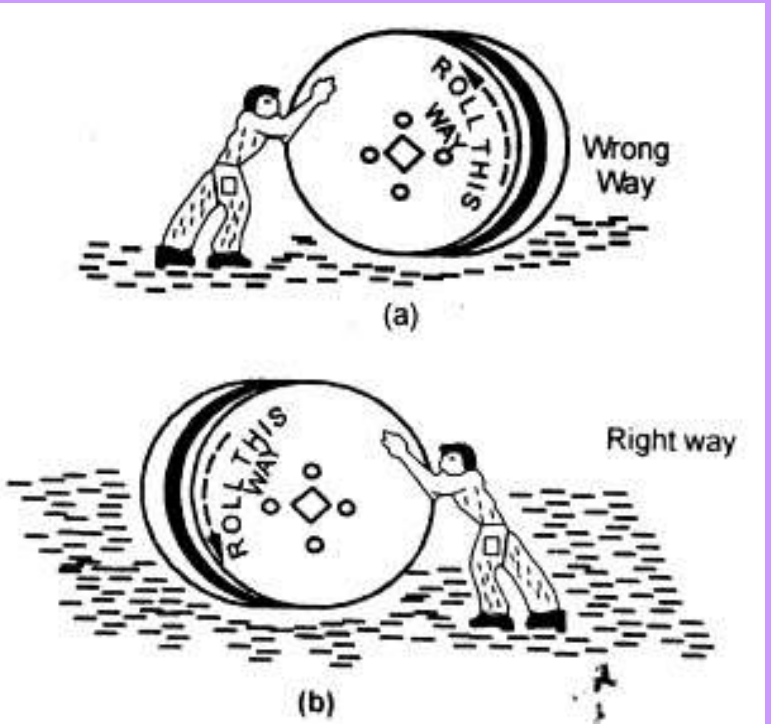
Control cable:- These conduct the low power of a few tens of a V.A. These cables are used for control measurement,monitoring,communication, protective, and electronic circuits.

According to types of insulation

- Paper insulated cable
- Poly vinyl chloride
- Polyethylene cable
- Poly tera ethylene cable
- Cross linked poly ethylene cable

Inspection of the cable:-

Before installation of the cables these should be inspected. Cables are generally available and solds in cable drums with several rounds of cable wound over it. The standard length of the cable are 250m, 500m,750m,1000m After receiving the cable drums at site cable packing should be checked for any damages to the drum.



Handling of cables:-

- Tools which are used for opening the cable drum must operate with at most care and ensure that tools does not damage the cables
- Check the arrow on cable drum for directions of rotation
- Check the continuity of the cable

Transportation of cable:-

Special truck are used to carrying the cable drums

Should be tied with the ropes ti avoid free falling during loading and unloading of cable drums.

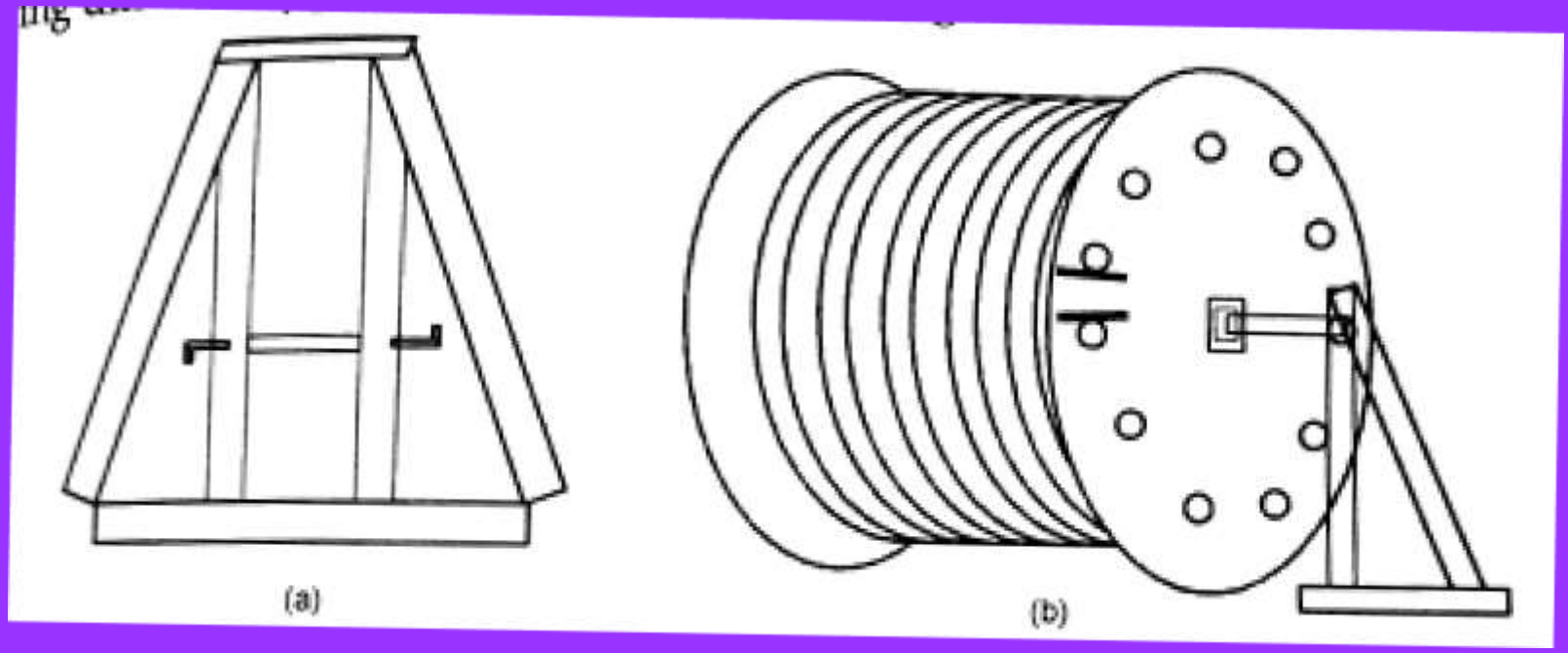
Storage of cable:- Cable drum should be stored at a place where free circulation of hair take place between them. Cable drum should be placed on smooth ground this will help in easily movement of cable drum. in damp situations it is a advisable to allow at least three inches gap between table drums for circulation of air.

Planning the route for cable laying:-

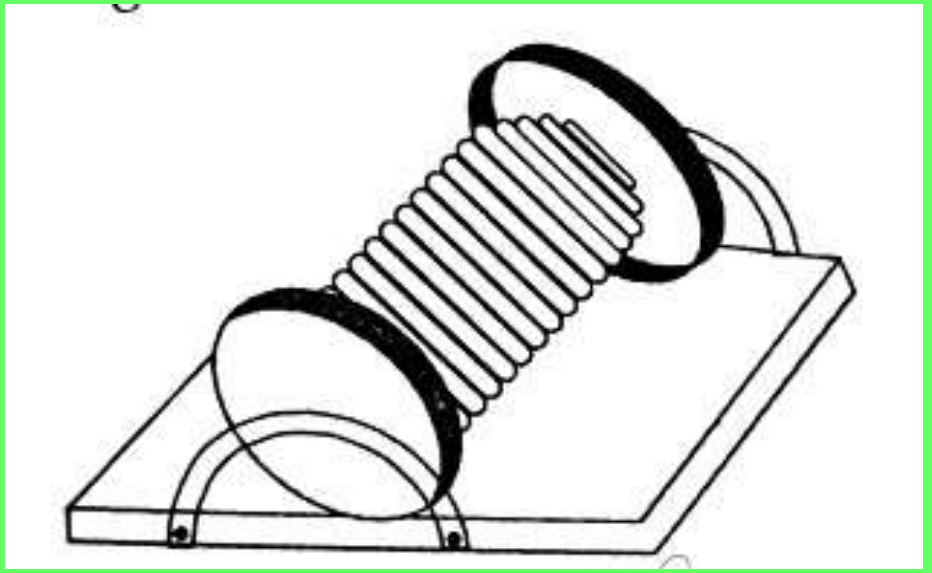
- Firstly survey of root of cable should be carried out
- The road should be shortest if applicable with minimum bends.
- While selecting the cable route corrosive soil and ground surrounding Sewer influent cell be avoided if it is not feasible then special precautions I'll be taken.
- Present and future condition shall be taken while deciding the future of cable such as cable route should not affect widening of roads etc.
- where cable cross is one another the higher voltage rating shall be placed at lower as compared to lower voltage cable.

Cable handling equipment:-

Jack:- jaikara used to lift the cable draw above the ground so that cable drum could be rotated easily. It will be help in unbounding the cable from cable drum. Following different types of jacks are shown in figure below.



Rollers:- As the name suggest there are used in pulling the cable on ground otherwise cable may be damaged. Hanging type rollers are used when cable to be installed at any height above ground level.



Winches:- These type of equipment help in loading and unloading of cable drum from truck extra

Cable laying depth and clearance:-

As per ISI specification of following depth from the ground level as under

Upto 11000v working voltage- 0.45+ radius of cable

3.3kv to 11kv voltage- 0.75+radius of cable

22kv to 33kv voltage- 1.0m+ radius of cable

Excavation of Trenches:-

The trenches are dug by any suitable means that is manual or mechanical along the the mark route. before starting the excarvation over the route should be properly check by other ground service department.

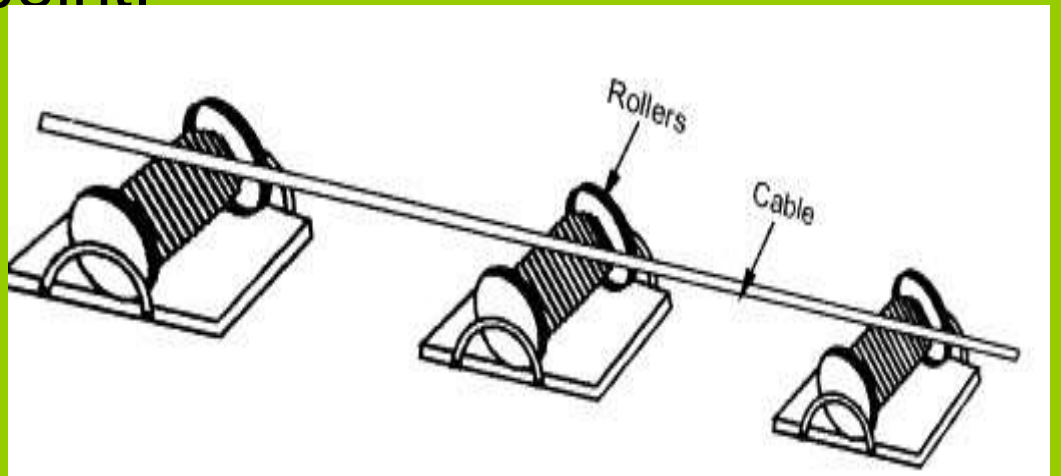
The bottom of trench is levelled. over the lavelled bottom of trenches a thickness of 8 centimetre of sand is prepared.

Method of laying of cable

There are two method of laying of cable

Direct cable laying method:-

There are various method of laying the table but direct laying method is more common. Material required such a cement bricks sand brought to the site. After this trenches are dug about 1.2 metre deep and 0.5 metre wide. A layer of sand is filled over the bottom of trench. The bottom of trenches should be leveled free from sharp objects stone and bricks bats extra. This method of laying the cable is simple clean and cheap point This provide better condition for heat dissipation point.



Back filling of Trenches:-

- The roller are removed from their position by lifting the cable to small height.
- In Trenches cable to be covered with dense layer of sand and then a layer of bricks. After this trench is filled with earth. to provide extra protection to cable brakes can be put on both side of cable.

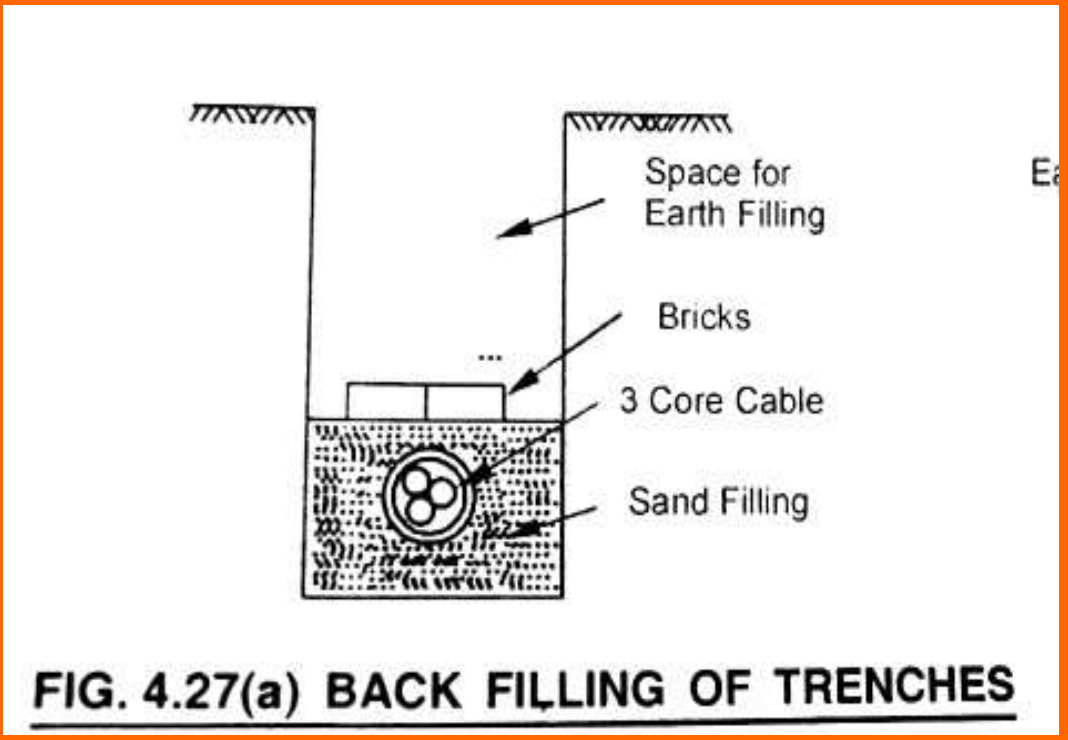


FIG. 4.27(a) BACK FILLING OF TRENCHES

Draw-in system:-

The system is employed where excavation is expensive and inconvenient. In this method of laying of underground cable line of conduit ducks made of iron or cement concrete ducks are laid in trenches side by side. the cables are pulled from manholes up to the duct by mean of strong ropes. The depth of trench should be such that top pipe remains at least 60 centimetre below ground level and width of trench depend upon number of pipe.

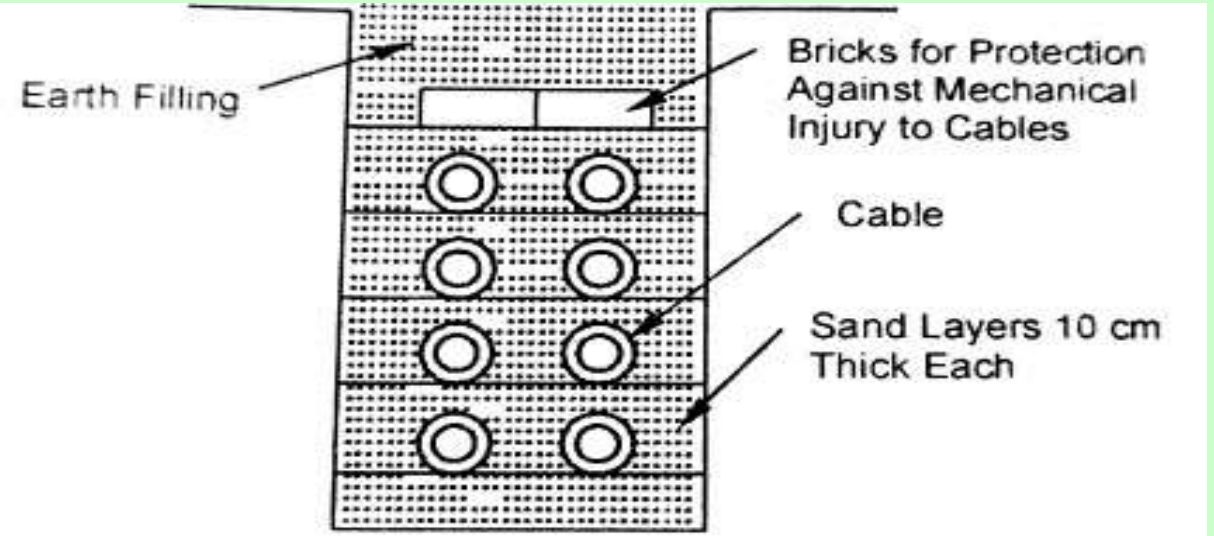
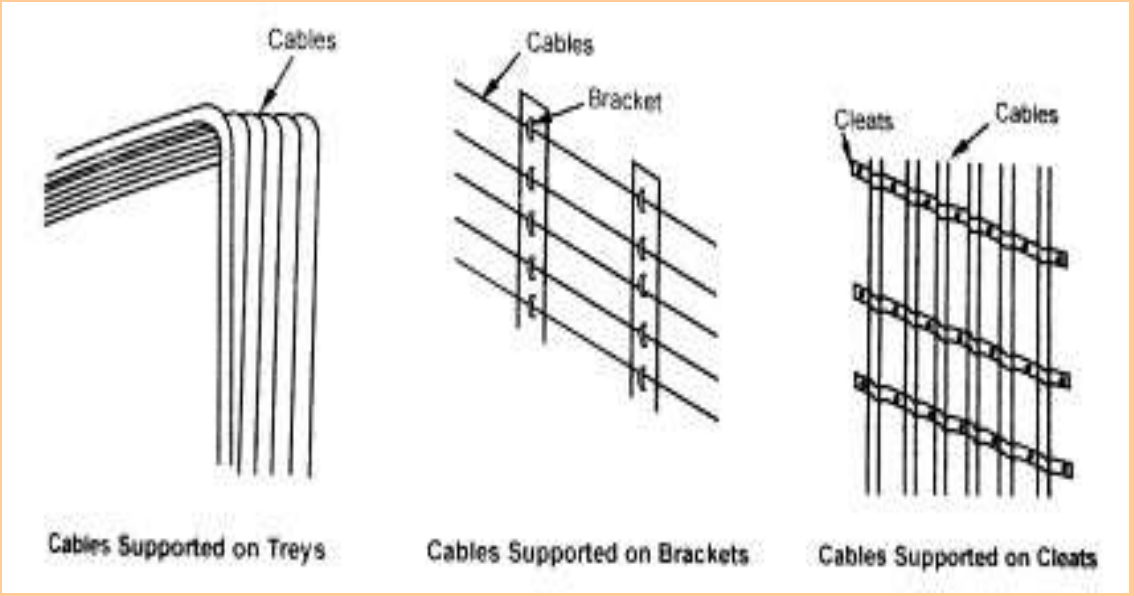


FIG. 4.27(b) DRAW-IN SYSTEM

Manhole:- It is the underground chamber where pipe and ducts terminate and which is employed for pulling in cable through the ducts and joining chamber for cable coming in and going out from it

Cable laying on surface:-

the cable may be laid on surface in switching /substation factories overhead busbar etc. The cable shall be laid in trough on bracket of fixed with mild steel clamp such as that there is no under say in the cable.



Cable jointing and terminations:-

Jointing:- The connection of two length of cable by suitable method which provide a continuous path for flow of current is called jointing.

Termination:- It is applied to the end of conductor in such a way that is suitable for connection to the terminal to which is to be connected by the mechanical means.

before jointing or terminations of the cable it is necessary to discuss the following terms:-

Cable glands:- The table and day matter in closed control boxes of cable through the cable glands. Glands are made of brass and stainless steel. types of cable glands that is single compression gland and double compression glands.

Cable sealing box:- It is used to seal the cabke ends at the terminating point where wires are taking out.

Classification of cable joints are cable box for cable termination:-

i. Classification based on application: termination jointing between straight length
ii. Classification based on material: epoxy junction box cast iron jointing box and lead jointing box

iii. Classification based on: straight T-shaped X-shaped

Method of cable jointing

Before jointing the conductor of cables in cable boxes conductor are dressed manually if their conductor cross section is less than 25 mm square. cable jointing is done by the following method

For copper conductor

1. Soldering
2. Compression

For aluminium conductors

1. Soldering
2. Welding
3. Riveting
4. Bolding
5. Compression

Precaution in cable jointing

- cable jointing work should be carried out immediately without wastage of time after cutting the cable
- Cable jointing work should not be undertaken in rainy season
- There should not be any services before the soldering
- correct grade of insulating material and box compound amended by manufacture of cable jointing system should be used
- after armouring properly clean the earth continuity conductor should be bolted at right place.

Cable filling compounds:-

The cable filling compound should have following properties:-

a. It should have a good adhesive property.
b. It should have high flash point that is 250 degree Celsius
c. Softening point should be high
d. It should not crack on cooling
e. It should have long travel free life

Testing and commissioning of cables

- Routine test
- Type test
- Special test

Routine test: These test are:-

- Conductor resistance test
- Insulation resistance test
- Power frequency (A.C.)high voltage test
- Partial discharge test
- Die electrical power factor

Types and special test

- Bending test
- Dielectric test
- Impulse withstand test
- Fire resistance test
- Insulation and sheath thickness test etc.

Commissioning:- after installation of cable at site 1 emission test are conducted on newly cables before energizing it.

a. Insulation resistance are major between conductor and earth. DC insulation resistance is measured by meggar
b. check that cable terminated inside a panel should have a cable glands.

Causes of failure of cables

- Mechanical failure
- Chemical causes
- Darkness aur moisture causes
- Overheating
- Insulation failure

Types of cable fault:-

Three types of cable fault:-

1. Ground fault
2. Earth fault
3. Open circuit fault
4. Short circuit fault

Ground fault:- when installation of cable breakdown then current start flowing from core to earth

Earth fault:- this type of fault taken place when conductor is broken of cable joint is open is known as open circuit fault

Short circuit fault:- when insulator between cores of the cable is damage then current flows from one pole to another pole.

Method of locating of fault:-

1. Ground or earth fault:- When installation of cable breakdown then current starts flowing from core to earth such for are called ground or earth fault.
2. Murray loop test:- this test is very common in this test a sound cable run along the faulty cable. wheatstone bridge principle are used for performing murray loop test. Short circuit and earth fault is used in this method.
3. Fall of potential test.

Precaution while working on cable and capacitor banks:-

1. A permit to work to be obtained before starting the work
2. Before any work on cable or capacitor is started it should be made that discharge and earth
3. After completion of work on cable is should be properly tag
4. In case star connected Bank of capacitor neutral point should be earth and before carrying out the work

Elementary idea regarding, inspection and handling of transformers

Sub-station:- It is an assembly of apparatus or equipment which transform the electrical energy from one voltage level to another voltage level substation are the most important part of power system.

Necessity of substation:-

- The generating station are for away from the load centres
- The generation of power from generating station must be discharged to the load centre
- The generation voltage is low it is step up and transmitted through lines to sub station located at load centre

Classification of substation

1. Classification on the basis of nature of duties

Step up substation or primary substation

Primary grid substation

Step down or distribution substation

2. Classification on the basis of voltage

High voltage substation i.e voltage between 11KV and 66kv

Extra high voltage substation i.e. voltage between 132 KV and 400 KV

Ultra high voltage i.e voltage above 400 KV.

3. Classification on the basis of importance

Grid substation

Town substation

4. Classification on the basis of design

Indoor type substation

Outdoor type substation:- outdoor type substation are further two types.

Pole mounted substation

Foundation mounted substation

Pole mounted substation

Pole mounted substation are erected for mounting distribution transformer of capacity upto 250 kilovolt ampere. Such substations are cheaper simple and smallest of sub station. All the equipments is of outdoor type and mounted on the supporting structure of high tension distribution line. Triple pole mechanically operated (TPMO) which is used for switching on and off high tension transmission line. HT fuse unit is installed for protection of high tension side. To control low tension side of ironclad low tension switch of suitable with fuse installed. Lightning arrester are installed over the high tension line to protect the transformer from the surges.

Diagram:-

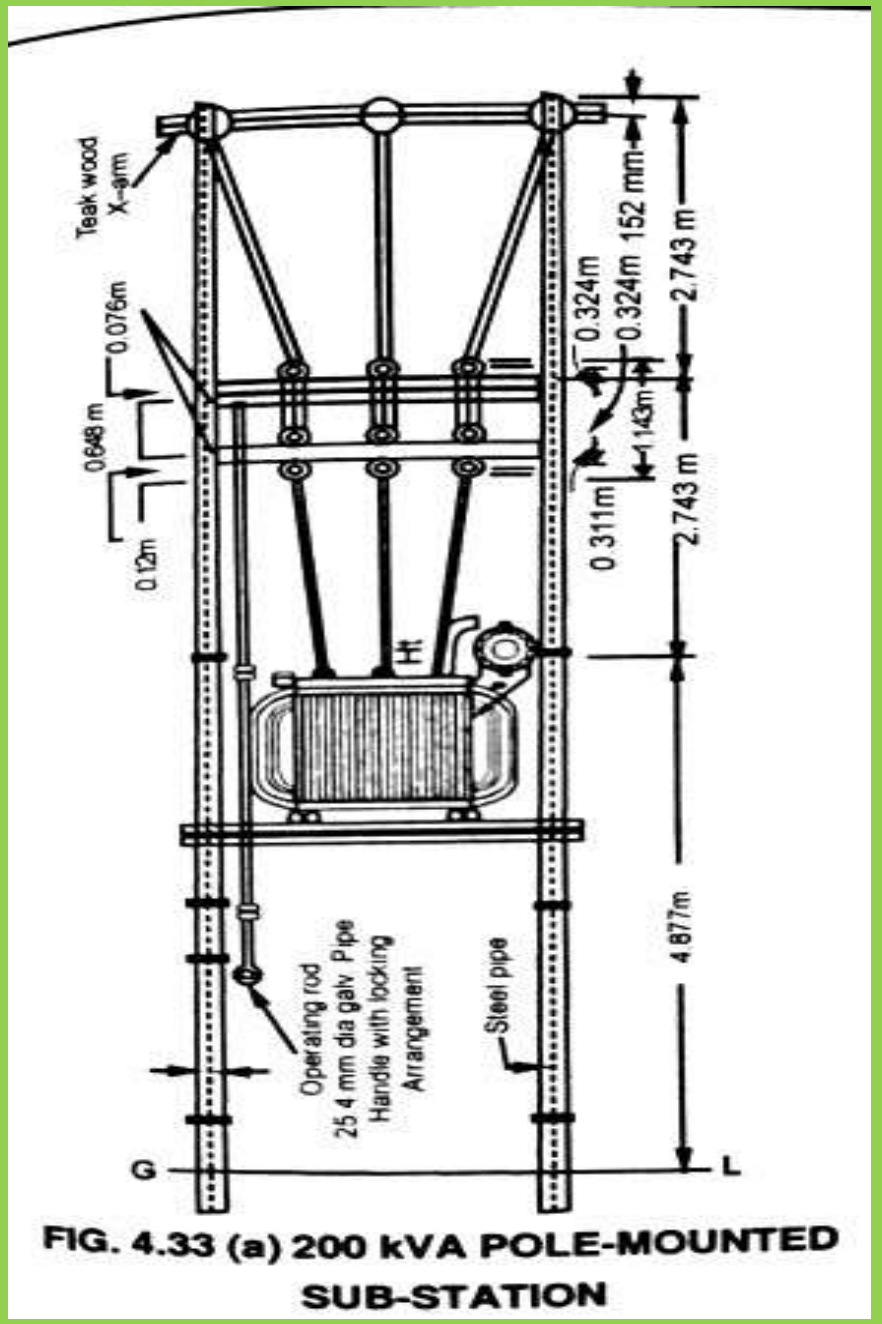


FIG. 4.33 (a) 200 kVA POLE-MOUNTED SUB-STATION

Land required for substation

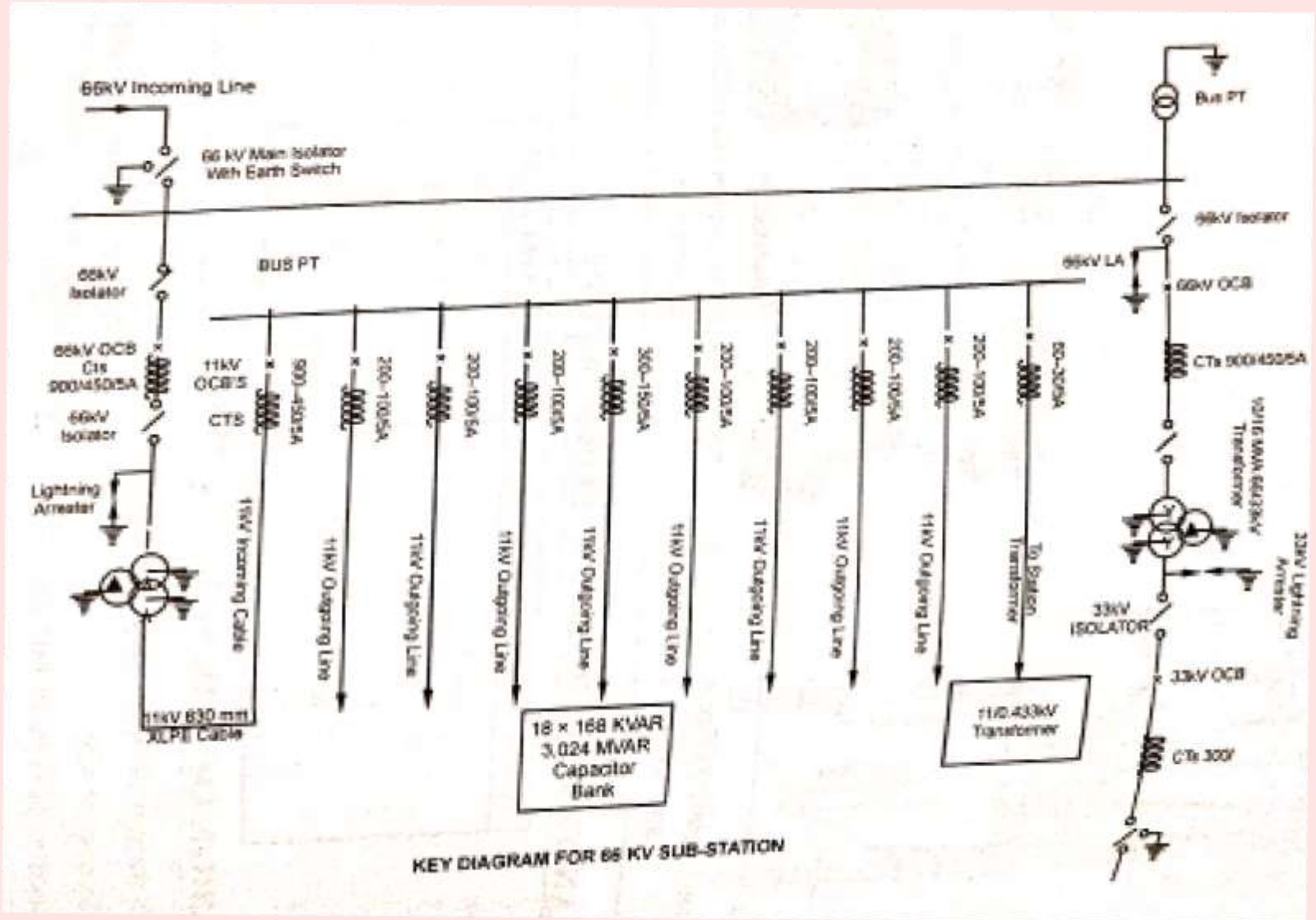
Type of sub-station(kv)	Area in acre
400kv	35-40
220kv	12-16
132kv	6-8
66kv	2-4
33kv	1-2

Design of the substation:-

I. Selection of site
II. Selection of switching scheme
III. Selection of type of busbar
IV. Design of bays width
V. clearance between phase to phase, phase 2toground, phase to earth for isolator.
VI. Design of earth mat
VII. Ground clearance
VIII. Main electrical equipment
IX. Design of layout
X. Auxiliary supplies
XI. Civil and electrical work

Key diagram:-

Key diagram of 66kv station

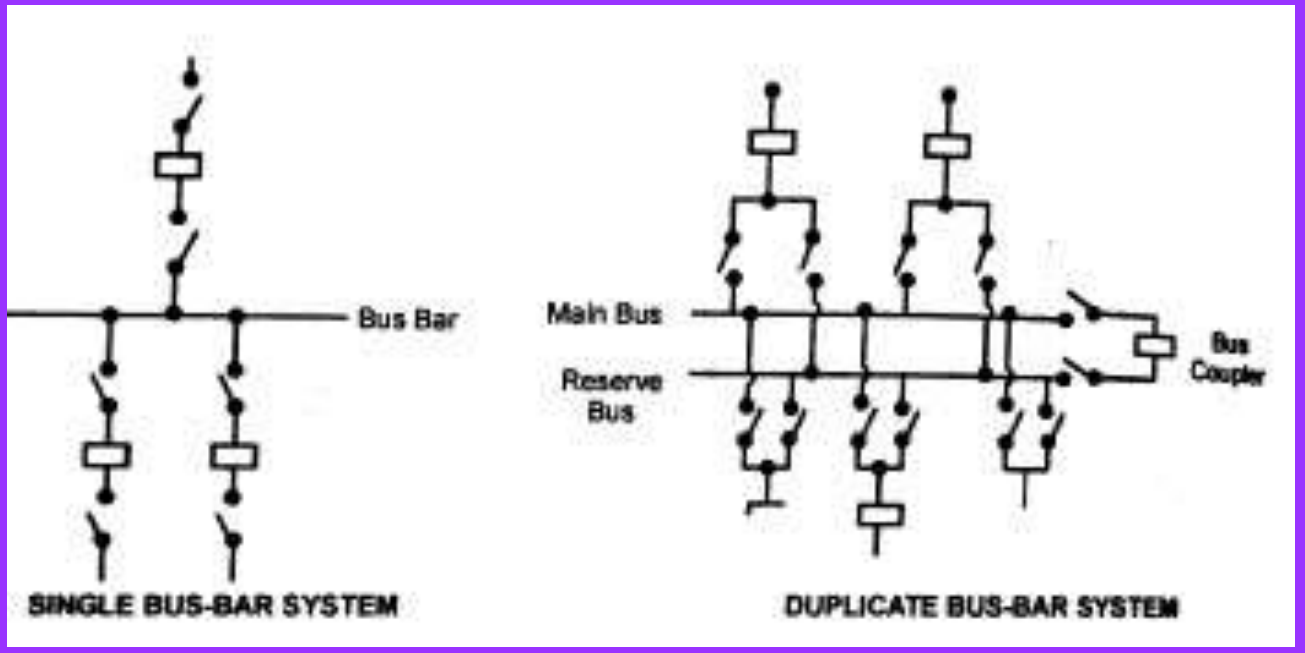


Grid substation:-

These are they substations from where bulk power is transmitted from one place to another place in the grid. These are important because any disturbance in the substation may result in failure of grid.

Bus-bars:- Copper aur aluminium conductor bar aur flats to which various incoming and outgoing circuit are connected known as busbar or simply a bus. bus bar receive power from incoming circuit and delivers power to outgoing circuits. the bus bar used in substation are generally rectangular in cross sections. the bus bar can be indoor or outdoor tubular type or a ACSR or AAC. These are rated in in ampere 200A,400A,600A,800A,1600A etc.
All rigid type busbar mounted on support insulator are coated with enamel paint of red yellow and blue colour to indicate different phases. in case of DC system postive busbar claret colour and negative busbar are blue in colour.

Diagram of Bus-bars



Isolator:- The switch operate under no load condition are called isolating switch.it provide isolation of a circuit for the purpose of maintenance.isolator are known as disconnecting switch. Isolator are interlocked with circuit breaker to prevent operation on load i.e circuit breaker cannot be closed until the isolator is closed and isolated cannot be open unless the circuit breaker is opened

Current and potential Transformer:-

Current Transformer:- CTs are used for stepping down alternating current from higher value to lower value for measurement protection and control purpose

Typical secondary current is 5 ampere RMS.

It is used to measure high current.

Potential Transformer:- PTs or VTs are used for stepping down AC voltage from higher value to lower value for measurement protection and control purpose.

Typically scandal voltage is 110 voltage RMS

the difference between power Transformer and instrument Transformer are mainly due to their rating. Power transformer have high KVA rating(500kva,1000kva upto 1000mva). instrument Transformer have rating of few tens of V.A, 30 VA etc

It is used to measure high voltage or EMF

Potential Transformer are also two types:-

Electromagnetic

Capacitor voltage transformer

Lightning arrestors: It is used in substation for protection of power system against the higher voltage surges it is connected between line and earth at the substation near the Transformer it is also known as surge arrester or surge diverter.

lightning protection is done by lightning arrester gap and overhead ground wire. Transmission line is protected from direct stroke by running a conducted known as ground wire over the tower and earth at regular interval at tower/ pole. substations and power our house are protected from direct stroke by earthing screen. The ground wire and earthing screen does not give protection against high voltage. so for this different protective devices are employed.

Diagram of lightning arrester

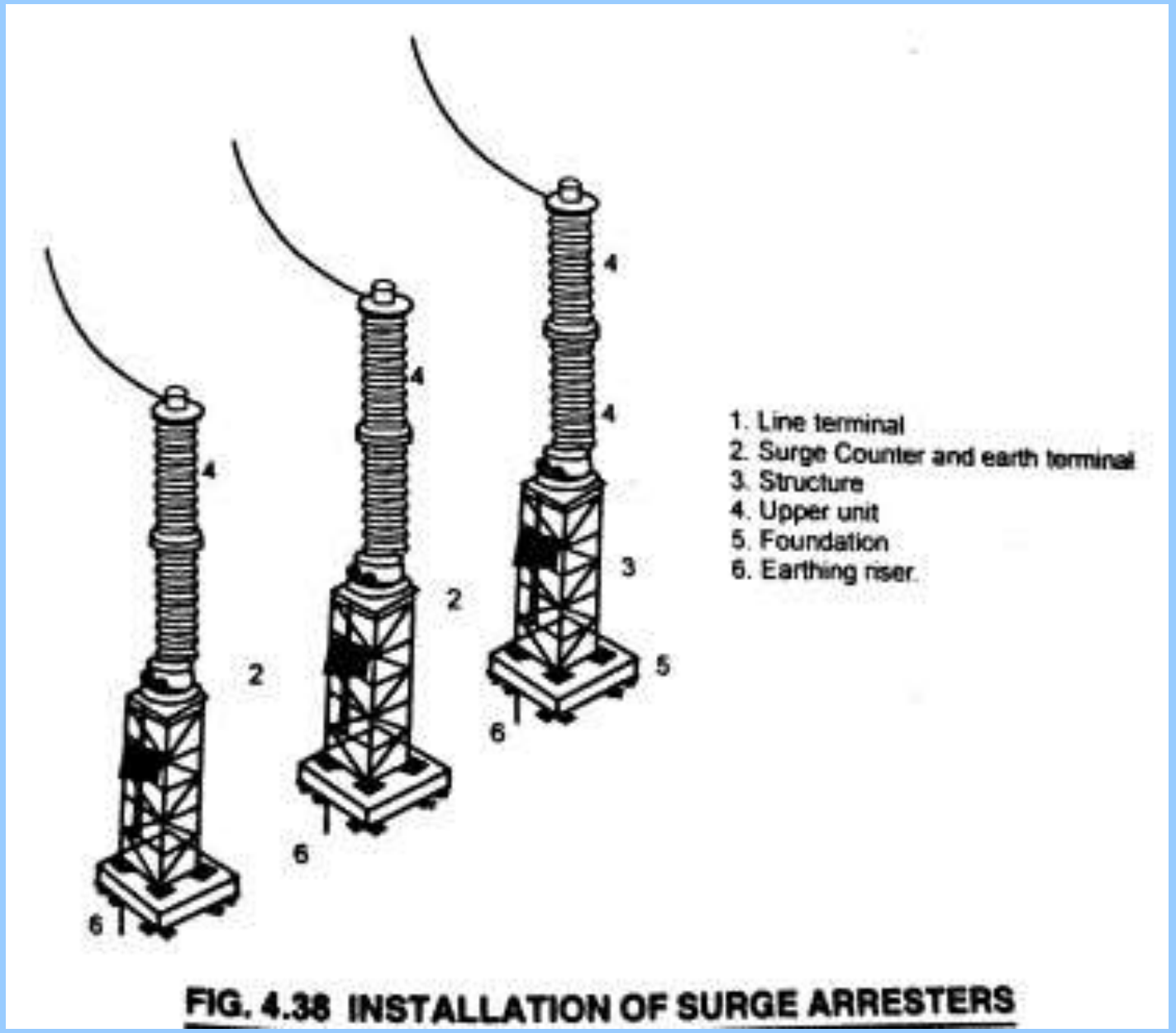


FIG. 4.38 INSTALLATION OF SURGE ARRESTERS

Control and relay panel:-

Protective relay is an electrical device interposed between the main circuit and the circuit breaker as shown in figure. the protective relay are automatic device which senses default and send signal to circuit breaker to open. All the delay have three elements sensing element, comparison element and control element

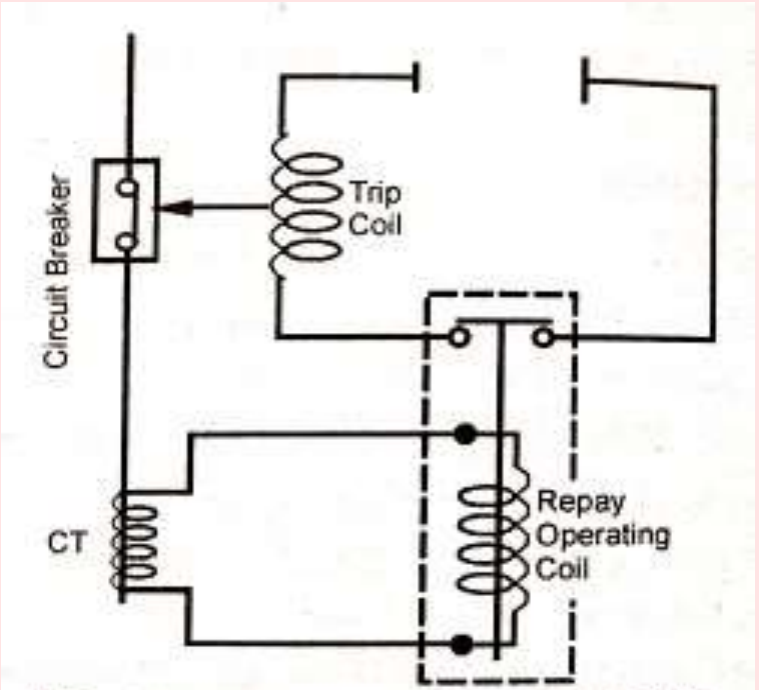


FIG. 4.39 TYPICAL RELAY CIRCUIT

HT and LT circuit breaker

H.T circuit breaker:- The circuit breaker about 1000v rating are called hightension circuit breaker.The circuit breaker cannot be used on DC unless specified by the manufacture. HT circuit breaker are classified as

BOCB:-Bulk oil circuit breaker

ABCB:- Air blast circuit breaker

SF6.CB etc.

L.T circuit breaker:- The circuit breaker disconnect d lighter kal circuit automatically from supply during abnormal condition such as overload short circuit power failure etc. LT circuit breaker are two types

LT OCB AND LT ACB.

LT switch:- Switch is used to connect or isolate an electrical circuit. L.T. switches are those in which fuses are also provided additionally to protect thr equipments against short circuit. LT switch are of air break type. The L.T switch are manually operated.

Installation of Distribution and power transformer:-

Power transformer:-

The transformer is static device except OLTC as no moving parts are involved. It transform energy from one voltage to another voltage level at same frequency. It is tge costilest equipments so regular supervision and maintenance is required to avoid its failure. Power transformer rating are between 5kva to 650 mva and very large transformer (250mva to 650mva) are installed in generating stations.

Distrubution Transformer:-

These are available in different size and generally installed in urban and rural distribution transformer. Their rating are 5 kva to 150 kva and upto 500 kva. They remain in operation for 24 hours a day irrespective of load. These transformer have good voltage regulation.

Dispatch of power transformer:-

the Transformer are dispatched by manufacture with main body filled with Transformer oil up to the coil and they ok. The oil level is reduced below the tank cover to provide the sufficient space in the tank for the oil expansion during transit on account of temperature variation. The Transformer are packed in a strong wooden packing for dispatch it over long distance. silica gel breather is fixed to the Transformer body to check the moisture free breathing due to ambient temperature variations. sometime the tank is without oil filled with dry nitrogen gas at pressure of 3PSI = 0.2kg percentage required at 35°c point in this situation all the opening in the tank and valves are closed so that nitrogen gas does not come out. All the other accessories are transported separately. As soon as Transformer reach the destination it should be exam in for case number agree with packing list and crates are not damaged.

Inspection and handling of transformers

After receipt of transformer at side gas pressure should be checked inside the transformer tank and recorded and to be intimated in writing to the manufacturer/supplier copy to higher officer also. if the pressure inside tank is zero report the matter immediately and fill the tank with dry nitrogen gas upto and internal pressure of 3 PSI at the earliest. Transformer received at site are always fitted with silica gel breather.

Handling:- Transformer should always be lifted by lungs designed to take the total weight of the unit. beside the lifting lungs transformer has subsidiary lifting points and take care must be taken to use right lifting point. normally in case of large transformer cranes are all used for lifting the transformers.

Storage of oil drums:-

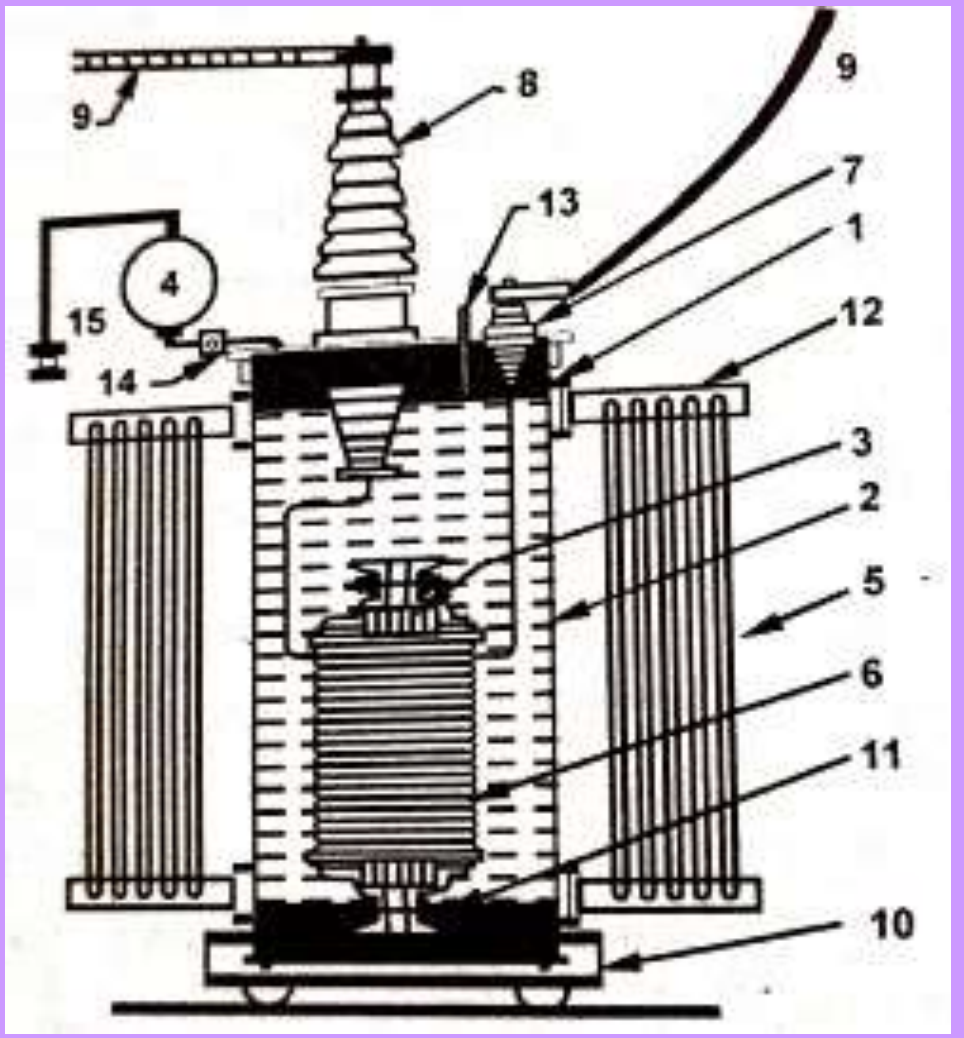
the oil drum should be stored at dry place in horizontal position with Bungs at 45° degree to horizontal in the downward direction. This will ensure that bungs are under the positive pressure. Drums should be away from fire hazards.

Site preparation for installation of transformer:-

The Transformer should be installed on level Foundation. The foundation should be strong enough to be the weight of Transformer and to prevent accumulation of water. Transformer Foundation should be provided drainage facility of oil during fire and emergency. Transformers should be installed in such a way that easy access is available all around and rating of diaphargram plate the metre valves oil level indicator can be easily read or reached. for the Transformer installed in the room must be ventilated so the air circulation can be done easily there. When roller are fitted, suitae rails all tracks should be used and grease the saft

Important fitting and accessories of transformers:-

1. Lifting lungs
2. Rollers
3. Bushing
4. Conservator
5. Diaphargram explosion vent
6. Radiators
7. Earthing terminal
8. Breather
9. Oil level indicator
10. Remote
11. Markshalling kiosk
12. Fans
13. Off circuit tap changing switch
14. Current Transformer



Filling Transformer with oil:-

before filling the oil tank it should be tested to meet the requirement laid down for oil. In case the oil does not meet the requirement filter and make it usable. When winding out of, oil filling will be done under vacuum only, before the oil filling all the accessories such as plunge and valve gears must be fitted of Transformer. All the air vents should be open. It should be filled with the help of metal hoses from oil filter tank point the oil should be filled only after testing and passing through filter

Testing of Transformer oil:- The property of Transformer oil are recommended as per IS 335- 1972 the fresh dielectric oil has a pale yellow colour. A dark cloudy colour indicate that deterioration as it contain moisture, dust particle etc.They lower down the dielectric strength of oil, so, the dielectric strength of soil should be tested by finding the breakdown voltage at which there is a visible arcing through oil across to electrode. This test is carried out in oil testing kit. A sample of soil is taken from bottom and top sampling valve. Oil should not be filled in sampling bottle completely, a space may be left for stopper on it.

Dehydration:-

The oil filtering equipments is used for filtering or dehrydration of transformer and switch gear oil. It is portable device. The oil is circulated in this decvice for several hours till the desired di-electric strength of oil is achieved.

OR The process in which moisture content or gases are removed from the transformer oil if any,is called dehydration of oil

Diagram of dehydration

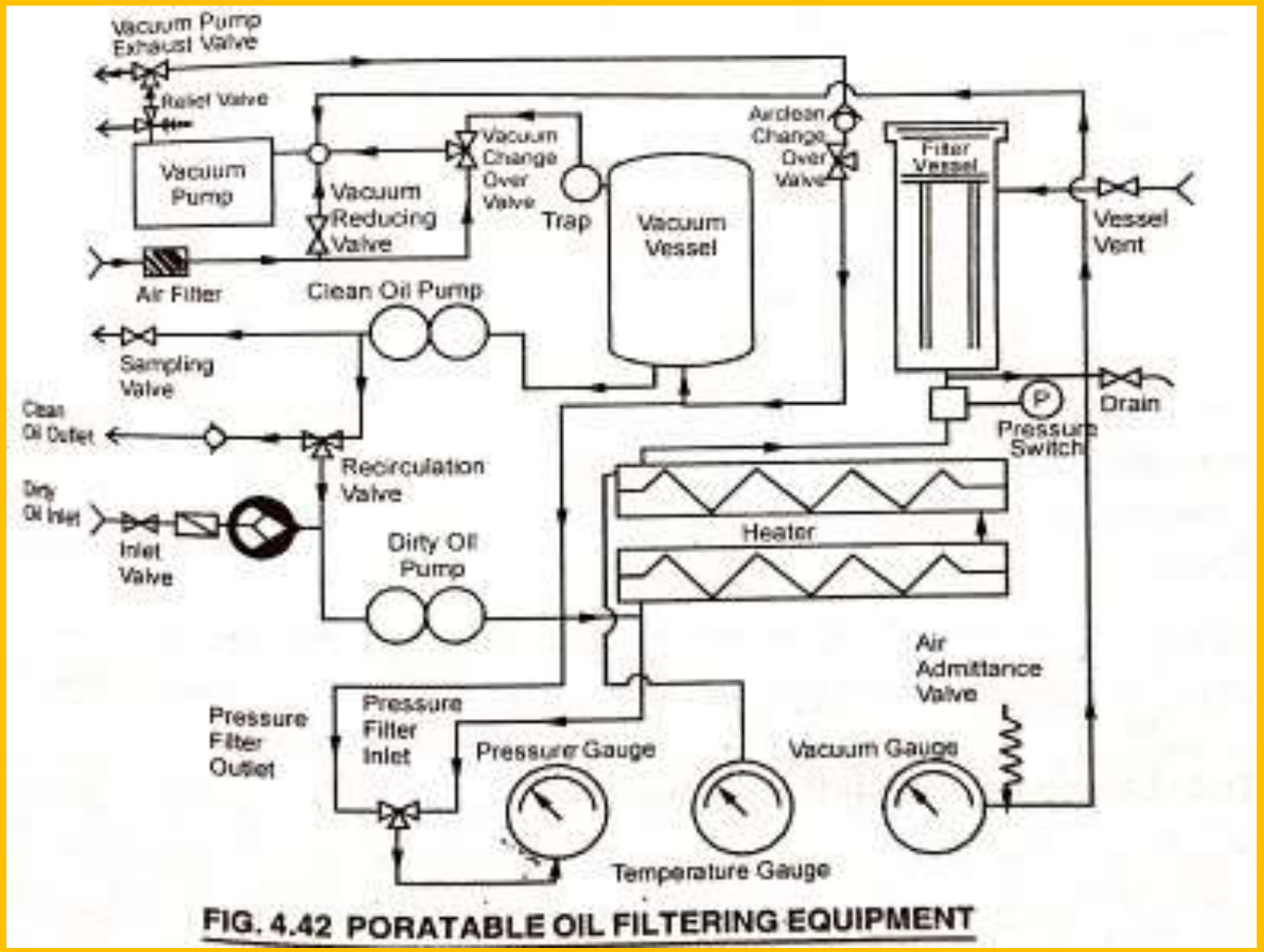


FIG. 4.42 PORATABLE OIL FILTERING EQUIPMENT

Earthing system:-

Earthing is done to provide a low resistance path to discharge current to the general mass of earth.

Earth mats and earth electrodes are placed below the ground level. These are connected to equipments structures and neutral points for the purpose of equipment and neutral point earth.

Fencing of yard:-

As per I.E rule 1956, 68(b) outdoor substation except pole mounted sub-station be efficiently protected by fencing not less than 2.4m in height or other means so as to prevent access to electric supply lines and apparatus there in by an

Unauthorized persons and animal etc.

Foundation and trenches:-

Foundation work are carried out by civil engg. Staff as per the maps or drawing of layout of substaions provided by manufacturer. All the switchyard equipment such as transformer, C.B,post,isolator, earthing mats require a good foundation.

Testing and Maintenance of Electrical Equipments

Electrical motor:-

Storage of a motor or machine:-

- The motor should be stored in dry and clean place.
- Temperature should be uniform otherwise it will cause differential expansion.
- Heaters should be provided to avoid dampness
- Motor should not be placed on mud or loose earth floor
- There must be No smoking sign in the store room

Testing of motors

- Insulation resistance measurement
- Rotor and stator resistance measurement
- Blocked rotor test
- Open circuit test
- No load test

Routine test

- IR measurement
- High voltage test
- No load test
- Locked rotor test

Special test

- Polarization index measurement
- Vibration test
- Sound level measurement
- Temperature rise test

Testing of Transformer:-

After installation work testing of transformer and its sub-system are carried out to check desired performance as per specification of the equipment.

Routine test:- These test are carried out in manufacture premises on every transformer.

- Ratio test
- Polarity test
- Insulation resistance test
- High voltage with stand test
- Breakdown value of oil
- No load test
- Test on load tap changer
- Resistance of winding
- Magnetising current test
- No load losses

Test of Transformer oil

a good oil should have combination properties of physical, chemical and electrical characteristics before discussing the test on Transformer oil the:-

property are discussed here properties of Transformer oil as

a. the oil should not contain suspended partical such as acid water sulphur etc.
b. the colour of oil should be clear pale yellow colour.
c. The Transformer oil have good resistance to electrical stress.
d. It should have low viscosity.
e. It should have thermal stability and excellent oxidation.

Various test

1. Physical test:- specific gravity, viscosity, pour point crackle test.
2. Chemical test:- neutralization number or acidity test, sapoxfication test, oxidation stability
3. Electrical test:- dielectric strength of oil, resistivity of oil, water content test, total acidity test, resistivity of oil

Testing of cable:-

A single conductor insulated through its full length is called a cable.

Testing:-

a. Routine test
b. Type test
c. Special test

Method of locating cable fault:-

- Ground fault of single cable
- Loop test
- Fall of potential test

Motor control centres:-

Motor control centre consists of switch fuse starter protection relays and conductor extra.

Starters:- Motor draw high current at starting this hai current mein damage the armature Hence motor. To avoid such situation we use starter. the starter are used for limiting the starting current to safe value.

For DC shunt and compound motor

3 point starter

4 point starter

For DC series motor

2 point starter

For AC motors

Direct online starter upto 5 HP

Star delta starter

Auto transformer starter

Protective relays

Release A device which sense of fault or short circuit and send a signal to the circuit breaker for tripping.

Voltage control relay

Current operated relay

Sensitive relay

Contactors:- Contactors electromechanical device used for making and breaking of an electric circuit under normal and overload condition. These are not operated under abnormal condition. like a circuit breaker contactor are extensively used in motor control circuit example motor starter and other control circuit using interlock.

Maintenance of motor control centre

- Maintenance of starter
- Maintenance of protective relays
- Maintenance of contactors

Power control centre

The apparatus used for switching controlling and protecting the electrical component in industry or substation are known as power control centre or simply switchgear.

Types:- switch

Circuit breaker

Maintenance of power control centre

- Check all the fuse for circuit continuity
- Remove dirt and dust from switchgear installation
- Clearing of all airbrake switches switches isolator and earth switch etc.
- Tight the nut and bolt
- Checking of earthing conductor system
- Check them for contact pressure

- Lightning arrangement

There must be proper and healthy lighting arrangement in a switchyard roads and control room building along with the standby arrangement. These are essential for operation maintenance and inspection purpose in substation.

Inspection of pre-installation checks

When the monetary received at site it should be properly checked as per the manual or instruction provided by the manufacture. If the packing is OK then it should be unpacked carefully. All the parts and accessories are properly examined as per the instruction provided. if there are any missing damaged item it should be brought to the notice of supplier or manufacturer immediately. after this instruction resistance of stator and motor windings are measured with the help of megger. If it is not satisfactory then the winding should be dried. Inspect the windings leads, brush, gear, bearing, commutator of slip ring, oil gauges etc. Check the router for easy rotation by moving it with the hand. If any type of dust seems on motor, remove the same by blowing.

Pre-Commissiong check

Mechanical and electrical checks are required before commissioning of motors are energised.

Mechanical checks

In mechanical checks correct alignment, air gap between stator and rotor, proper greasing of bearing, cheque clearance between rotor and stator check tightness of terminal connection should be carried out.

Electrical checks

Before connecting machine to the mains all connection should be checked with the wiring diagram. Rating of fuses should also be checked. Check the insulation resistance of the machine. Check the earth connections for tightness and measure earth resistance. Where relays are employed test should be performed for checking of relay stimulating loading conditions. Performance tests such as no load, full load, short-circuit, speed control tests are also carried out.

Drying out of motor

if the insulation resistance between the winding and earth major is less than 1 mega ohm then it mean that moisture awesome dust particles are prevent in the winding of the motor and the machine need to be cleared and dry out.

- Blocked rotor heating
- Heating by heaters or lamps
- By oven

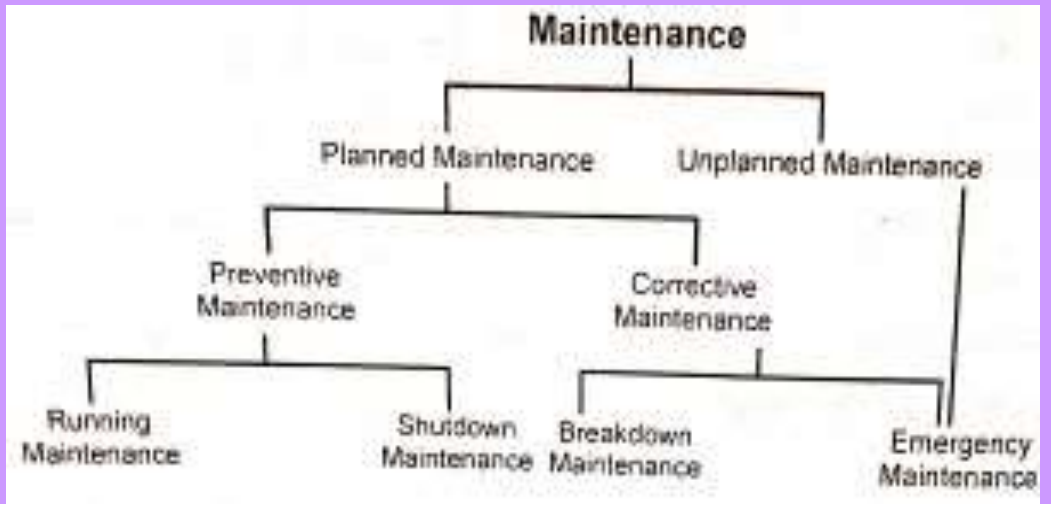
Chapter-3

Maintenance

Maintenance:- It is the process in which proper attention must be paid to protect the machine and its components a proper attention means lubrication cleaning and timely inspection it is important on a account of the following fact:-

- Machine breakdown cause a possible loss of production and their by sales
- Direct labour and part of indirect labour become idle
- Actual cost of repairing and machine is also involved

Types of maintenance:-



Planned maintenance:-

The terms in the maintenance work carried out in plant and orderly manner. It is two types.

1. Preventive maintenance
2. Corrective maintenance

Preventive maintenance:-

In this type of maintenance effort are made to prevent failure and to locate the faults.

Running maintenance

Shutdowm maintenance

Corrective maintenance:- This type of maintenance is carried out to restore the equipment to its original working condition.

Breakdown maintenance

Emergency maintenance

Maintenance schedule:-

There are different maintenance schedule for all electrical apparatus and component used in genration or Transmission system. These maintenance schedule helps in unkeeping the equipment in proper amd good working condition before discussing the maintenance, we will discuss some testing amd comissioning of transmission line.

Maintenance of transmission and distribution system:-

Maintenance of overhead:- overhead line, their structure and their components should be maintained to be in a safe operating condition.

A system of maintenance of overhead line, their structure and component consist of

- Inspection or testing programs
- Maintenance program
- replacement program for component approaching the end of their serviceable life
- Tree management program to ensure public safety
- Minimise lyrics of fire caused by contact between trees and overhead lines
- Reduce the number of introduction to supply caused by tree and
- protect the electricity distributors assets from damage

Authorised person:-

One who is properly authorised to perform specific duties under certain condition for who is carrying out order from competent authority and as defined under rule 3 of IE rule 1956.

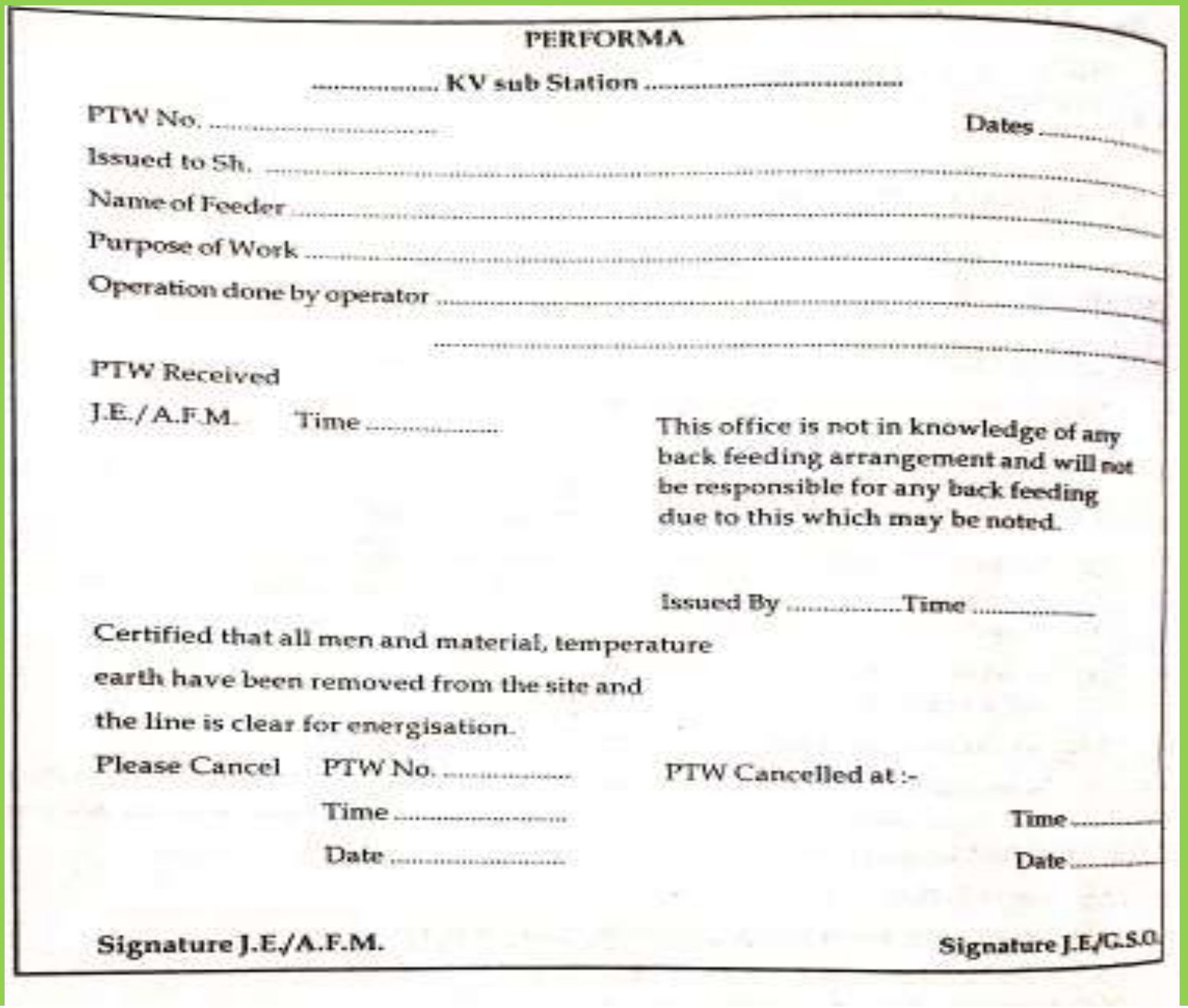
Unauthorised person:-

One who is not permit to work on electrical apparatus except under the personal supervision of an authorised person.

Permit to work:-

permit to work means form of declaration signed by and given by an authorised person to another authorised person in charge of work to be carried out to any electrical apparatus main of service line means or service line are made dead and earth and safe for working.

- Perfoma of PTW(permit fo work)



PERFORMA

..... KV sub Station .....

PTW No. ..... Dates .....

Issued to Sh. .....

Name of Feeder .....

Purpose of Work .....

Operation done by operator .....

.....

PTW Received

J.E./A.F.M. Time .....

This office is not in knowledge of any back feeding arrangement and will not be responsible for any back feeding due to this which may be noted.

Issued By .....Time .....

Certified that all men and material, temperature earth have been removed from the site and the line is clear for energisation.

Please Cancel PTW No. .....

Time .....

Date .....

PTW Cancelled at :-

Time .....

Date .....

Signature J.E./A.F.M.

Signature J.E/C.S.O.

Danger notice:- Danger notice means a notice attached to live electrical apparatus line calling attention to the danger of touching such apparatus. It is provided at height of 3.0 m from the ground. Every line must have a danger plate as IE rule 35. A danger notice about the line is written in hindi or english and local language along with a sign skull and bones.

Caution notice:- caution notice means a notice attached to the dead electrical apparatus to convey a warning against such equipment being made live.

Arranging of shutdown personally or telephonically:-

when return permit cannot be given line clear should be given and taken over on the telephone. in such case substance there of shall be repeated by the person who receive the line clear message and shall be confirmed by the standard to ensure that both parties are quite clear as to its purpose. search instruction should be recorded only in permit books at both sending and receiving end. the issue of line clear over phone should be confirmed by some other department employee to this supervisor over phone and name of that person who confirm the issue of line clear permit to work should be recorded in the line clear permit book. Duplicate copy of line clear should be send by post as soon as possible for record at either end after cancelling the same.

Cancellation of permit and restoring of supply:-

PTW form issued to the supervisors shall be returned to permit issuing officer only after all the work are completed and earth remove so that apparatus main and O.H line are safe in all respect horse charging and after all the workmen are withdrawn from the working area and our suitably be warned that it is no longer safe to touch the apparatus within said area.

Special inspection and high inspection:-

The overhead line should be inspected regularly for maintenance purpose in order to detect the fault which may ultimate lead to breakdown of this line there by causing extensive damage to power supply.the cost of maintenance increased manifold is a major breakdown occur in addition to loss of electrical power supply to measure electrical installation

leading to production shutdown and disruption in emergency electrical service.

Patrolling of overhead line:- all overhead line should be patrolled periodically at interval of 3 month. In case of heavy snowfall or thunderstorm it should be checked immediately for major breakdown. After patrolling the maintenance section should carry out of the necessary repair ever required.

Patrolling and visual inspection of lines

Visual Inspection:- visual inspection of electrical installation which is not considered is carried out Prior to any testing.starting the inspection cell include a check on the condition of electrical equipment and material and will take following factor into account

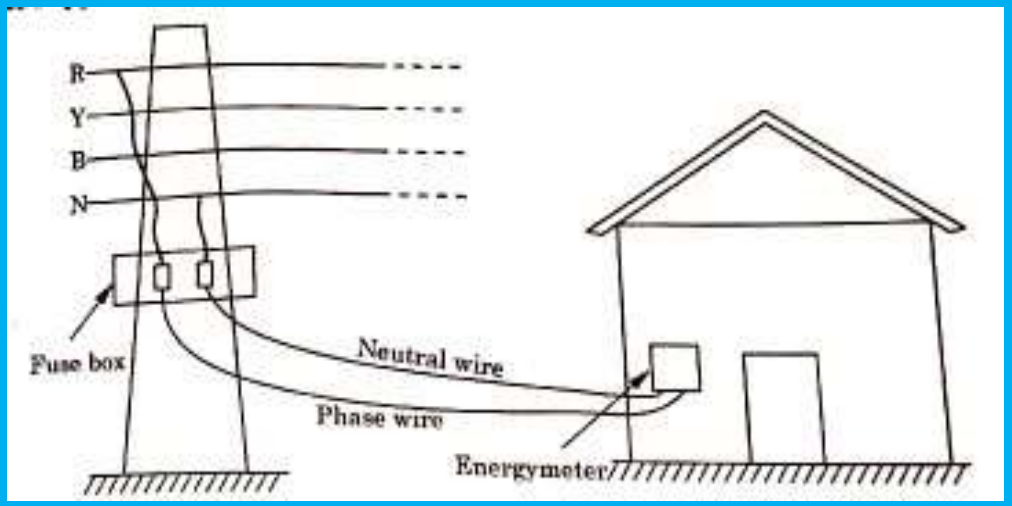
1. Safety
2. Wear and tear
3. Damage and corrosion
4. Overloading and overheating
5. External influences
6. the insulation and seat of each conductor at a sample of termination point shall be inspected to determine its condition and correct installation.

Effect effect of open or loose neutral connection:-

when the neutral is not connected or remain open or loose under such condition the neutral will assume a potential which will is determined by the load on each phase and in such a case neutral is called floating neutral. To explain this there may be three cases first case when balance load on 3 phase than voltage between neutral and each phase is same that is 230 volt if line voltage is 400 volt. If load are unequal in different phases. Voltage between all faces and neutrals will be different that is in some phase voltage will be low and in some phase voltage will be high. due to this several equipment may get damaged when lamp in 3 phase supply glow brighter than other of same voltage then it is an indication of something wrong with neutral connection.

Provision of proper fuses on service line and their effect on system:-

All the service line provided whether overhead or underground are provided proper fuse. A simple circuit diagram showing overhead service connection to domestic supply.



all the service connection are provided with proper fuse so that in case of fault within the zone between fuse box and energy meter the supply through the mainline being supplied remain infect by blowing of the fuse wire and electrical supply only to domestic installation get disconnected RMS provision of proper fuels affect the mainline from getting damage

Causing of Dim and flickering lights:-

the cause of dim or flickering light can be because of partially open connection providing varying resistance and therefore intermittent voltage drop.

This can be because of following reason:-

a. Bad terminal connection
b. Burned or broken wire
c. Bad or burned wires splice
d. Bad or burn light switch
e. Bad breaker etc.

even if there is nothing wiring is dry circuit and dim of flickering of light taking place it can be due to presence of large load on the same Francs circuit which may be causing this.

Temporary earthing:-

this is the most important phenomenon while carrying out the repair maintenance of electrical equipments. For temporary earthing stick or lose earth wire must be connected to earth first then to the phases. After completion of the work at sticker loose earth wire must be removed from the face first then from the earth.

Maintenance of Distribution Transformer:-

Transformer maintenance,checking of insulation resistance

The insulation resistance is measured with the help of megger insulation is completely dried up and all the moisture present is removed. The resistance of the installation depend upon the temperature at which the test is being performed for class eight insulation the insulation resistance get halves for every 10°c rise in temperature. The minimum value of insulation resistance 2Mohm for thousand volt operating voltage at 60°c temperature.the voltage generated by the generator during measurement of value should be steady.

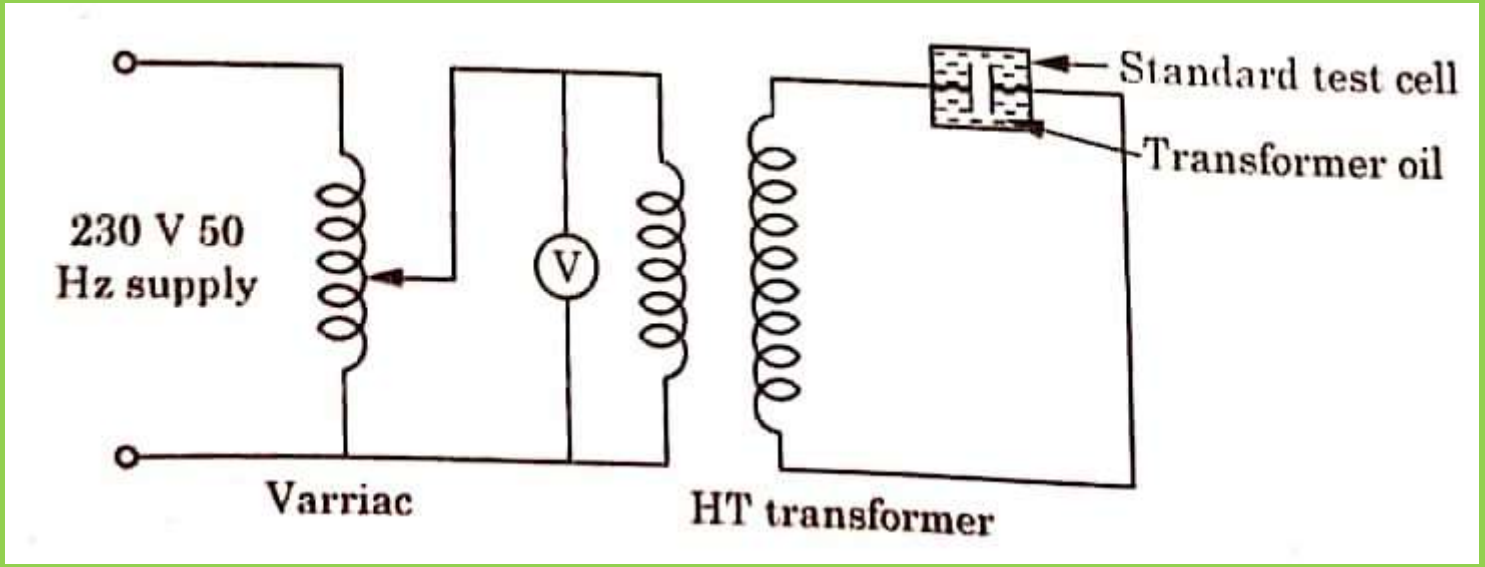
Checking of Transformer oil level:-

The oil level of the transformer is checked by looking at the level indicated in the printed fail on the glass installed at the conservator tank. the conservative tanks should be always be full of oil so that the oil which provide cooling effect to the temperature rise due to current carried by winding also provide insulation between the two winding of primary and secondary as well as between core and winding.

BDV test of oil:-

Breakdown voltage level test is conducted on the Transformer oil to measure its dielectric strength. The test is performed on a standard oil test set. This sample oil is taken and laced between two electrode of specified dimension as per relevant IS standard. The gap between these electrode is usually kept at 2.5 mm. The voltage applied across the electrode is gradually increased till a flashover take place.

the voltage level at which flashover take place is the dielectric strength of the oil. The arrangement of the test is shown in figure.



Measurement of earth resistance:-

Fall of potential method with the earth megger. the earth megger is used for measurement of her electrode for earthing system of small or medium extent such a single rod earthing electrode, strip earth electrode. The earth electrode the probe and auxiliary electrode should all lie in a straight line as for apart as possible. The distance of probe from the earth electrode test should be at least 2.5 times the maximum extension of this electrode but not less than 20 m.