OVERVOLTAGE PROTECTION IN POWER SYSTEM

UNIT - 5TH

SUB: ELECTRIC POWER-II

OVERVOLTAGE

- Increase in voltage for the very short time in power system is called as the over voltage. it is also known as the voltage surge or voltage transients.
- The voltage stress caused by over voltage can damage the lines and equipment's connected to the system.
- The voltage surge are temporary in nature and exists for very short duration but they cause overvoltage on the power system

EFFECT OF OVER VOLTAGE

- Over voltage tends to stress the insulation of the electrical equipment's and likely to cause damage to them when it frequently occurs.
- Over voltage caused by surges can result in spark over and flash over between phase and ground at the weakest point in the network
- breakdown of gaseous/solid/ liquid insulation,
- failure of transformers and rotating machines.

CAUSES OF OVER VOLTAGE :

1. **Internal causes**:

- Switching surges
- Arcing ground
- Insulation failure
- Resonance

2. **External causes:**

Lightning: An electric discharge between a cloud and earth, between clouds or between the charge centers of the same cloud is known as lightning

Lightning Facts

- A strike can average 100 million volt of Electricity
- Current up to 100,000 Amperes
- Can generate 54,000 °F

There are two types of lightning strokes

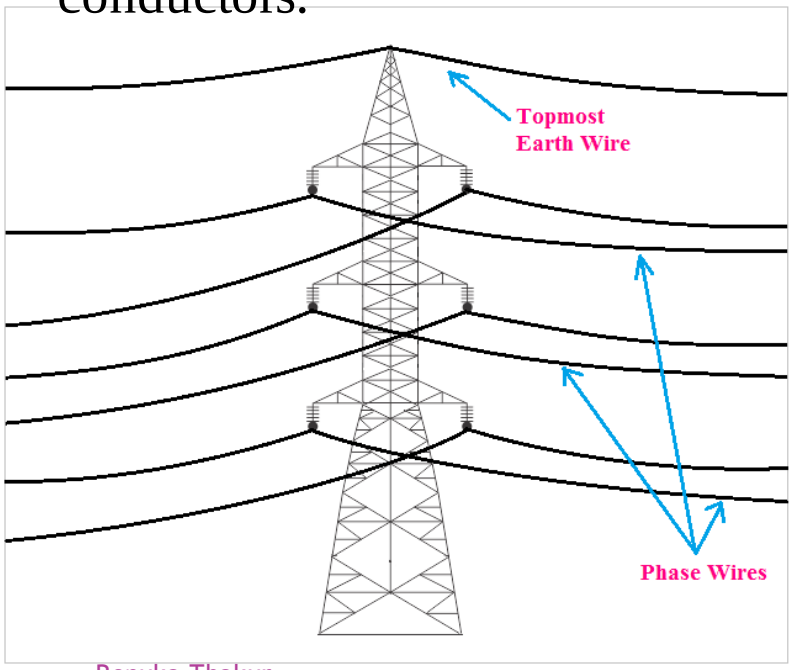
- Direct lightning strokes
- Indirect lightning strokes

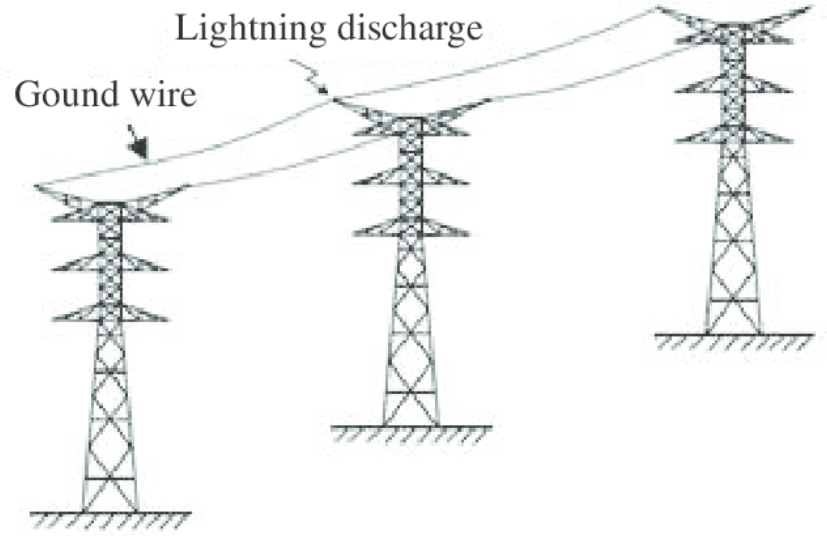
PROTECTION AGAINST OVER VOLTAGE

1. GROUND WIRES.
2. EARTHING SCREENS
3. LIGHTNING ARRESTORS OR SURGE DIVERTERS

OVERHEAD EARTH WIRE

- This method of over voltage protection is similar as earthing screen.
- The only difference is, an earthing screen is placed over an electrical sub-station, whereas, overhead earth wire is placed over electrical transmission network.
- One or two stranded GI wires of suitable cross-section are placed over the transmission conductors. These GI wires are properly grounded at each transmission tower.
- These overhead ground wires or earth wire divert all the lightning strokes to the ground instead of allowing them to strike directly on the transmission conductors.





EARTHING SCREEN

- Earthing screen is generally used over electrical substation.
- In this arrangement a net of GI wire is mounted over the sub-station. The GI wires, used for earthing screen are properly grounded through different sub-station structures. This network of grounded GI wire over electrical sub-station, provides very low resistance path to the ground for lightning strokes.
- This method of high voltage protection is very simple and economic but the main drawback is, it can not protect the system from travelling wave which may reach to the sub-station via different feeders.

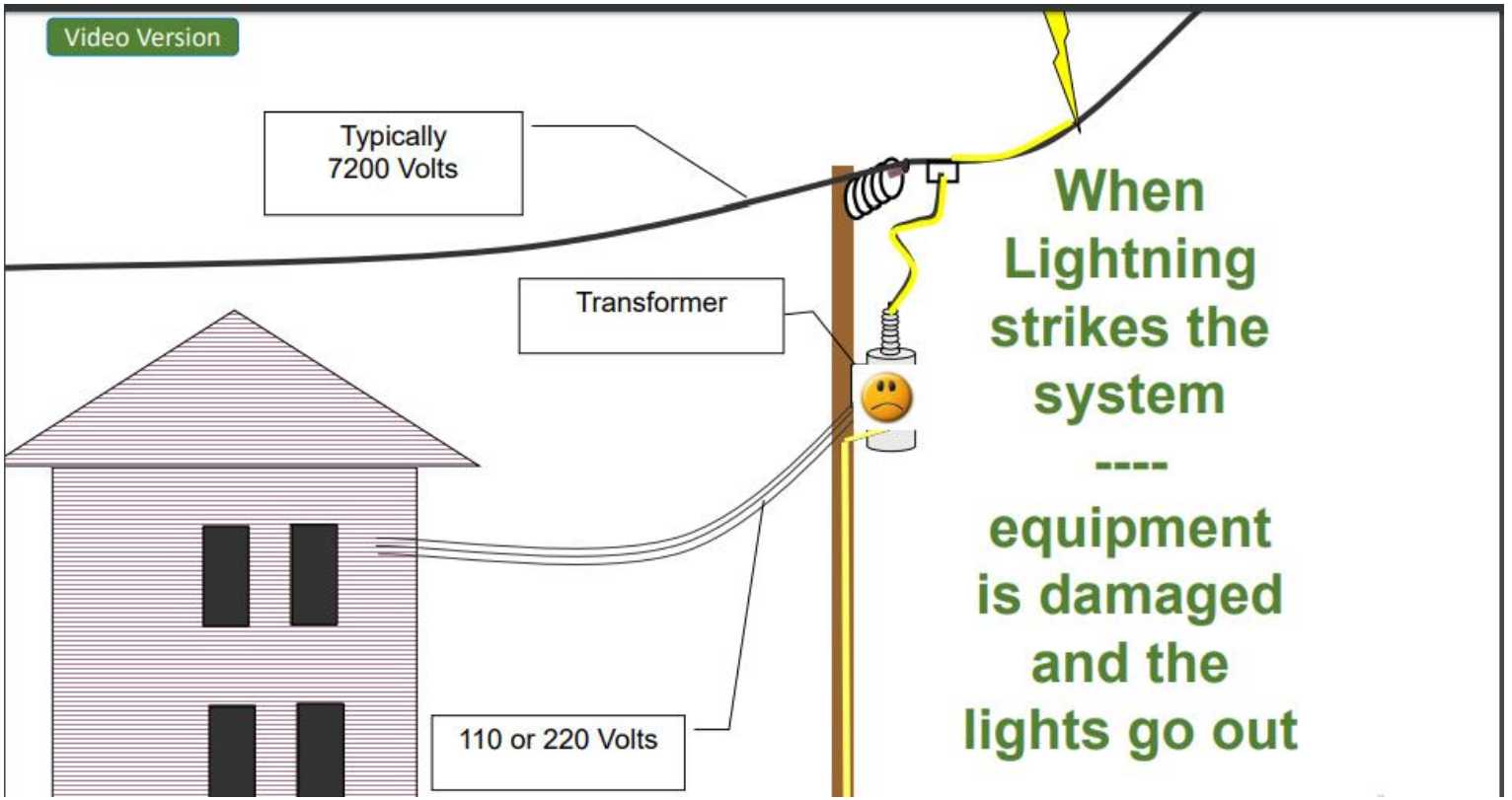
LIGHTNING ARRESTER

- Provide protection against high voltage travelling wave which may propagate through the line to the equipment of the sub-station.
- The lightning arrester is a devices which provides very low impedance path to the ground for high voltage travelling waves.

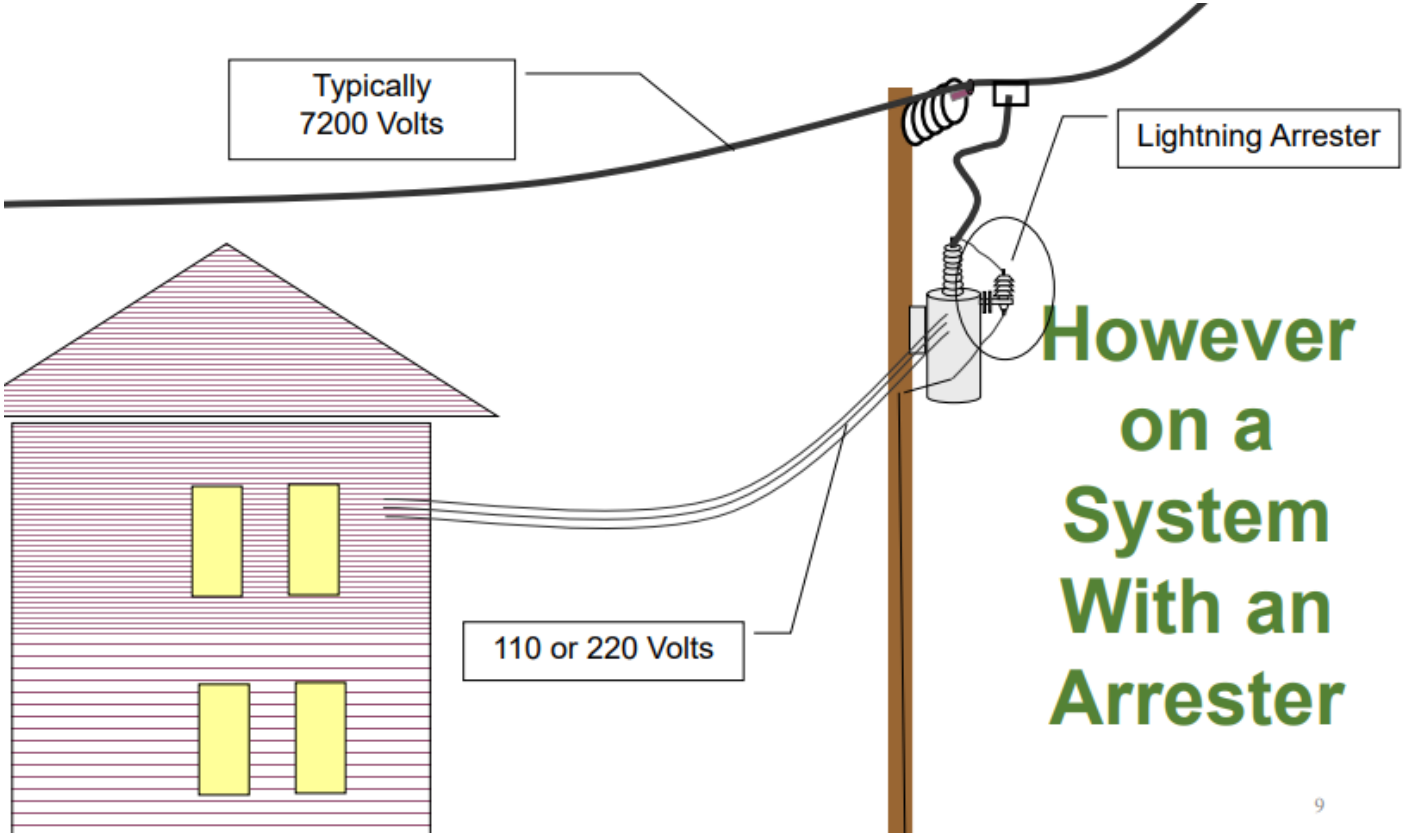
WORKING OF LIGHTNING ARRESTER

- Under normal voltage level, these devices withstand easily the system voltage as electrical insulator and provide no conducting path to the system current.
- On occurrence of voltage surge in the system, these devices provide very low impedance path for the excess charge of the surge to the ground.
- On removal of voltage surge it regains it original state.

WITHOUT LIGHTNING ARRESTER



WITH LIGHTNING ARRESTER

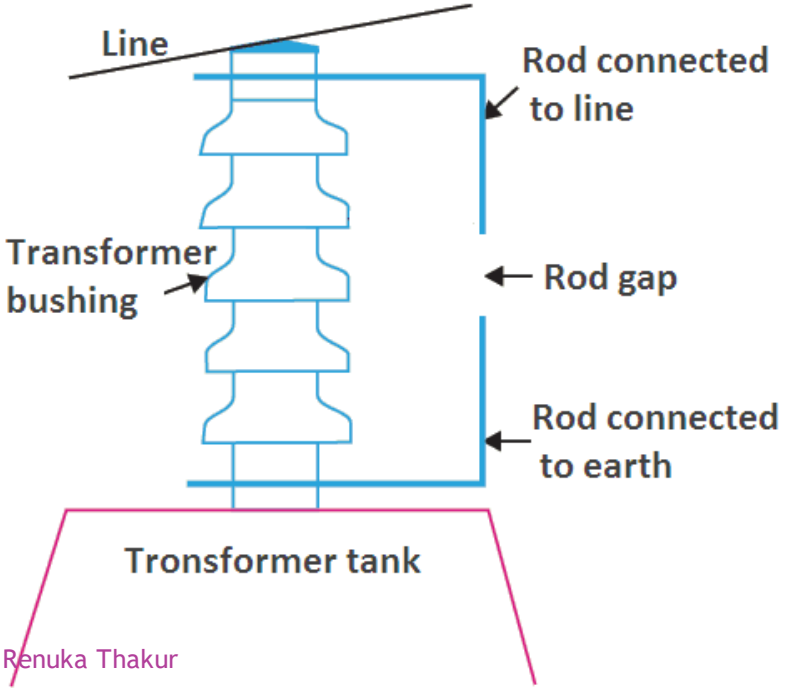


TYPES OF LIGHTNING ARRESTER

1. Rod Gap arrester
2. Horn Gap arrester
3. Expulsion type arrester
4. Electrolytic arrester
5. Valve type arrester
6. Metal oxide type

ROD GAP ARRESTER

- It is the simplest type of lighting arrestor. It consist two-rod electrodes, one of which is connected to the line and other to earth. The rods may be in the form of horn also.
- Under normal operating conditions, the gap remains non-conducting. When a high voltage surge occurs, the gap sparks over and surge current is drained to earth.



Such arresters suffer from the following Disadvantages:

- The operation is affected by climatic conditions.
- After the surge is over, due to ionization of air, the arc in the gap is maintained even at the normal supply voltage.
- Increased possibility of bird faults.
- Due to the above disadvantages, the rod gap arresters are used only as a ‘back-up’ protection with main arrestors.

HORN GAP ARRESTER

- It consists of two horn shaped metal rods A and B separated by a small air gap.
- The horns are so constructed that distance between them gradually increases towards the top as shown. The horns are mounted on porcelain insulators.

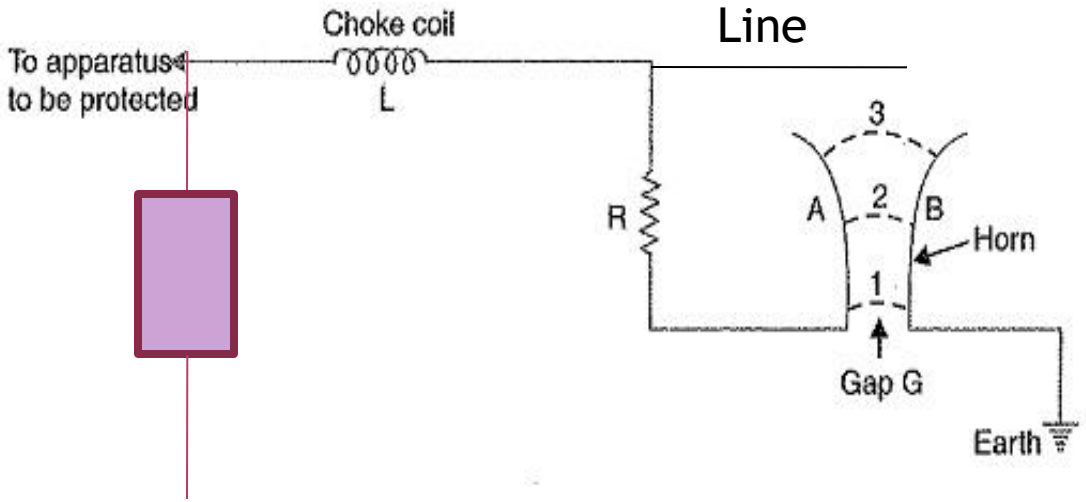


Fig. 24.10

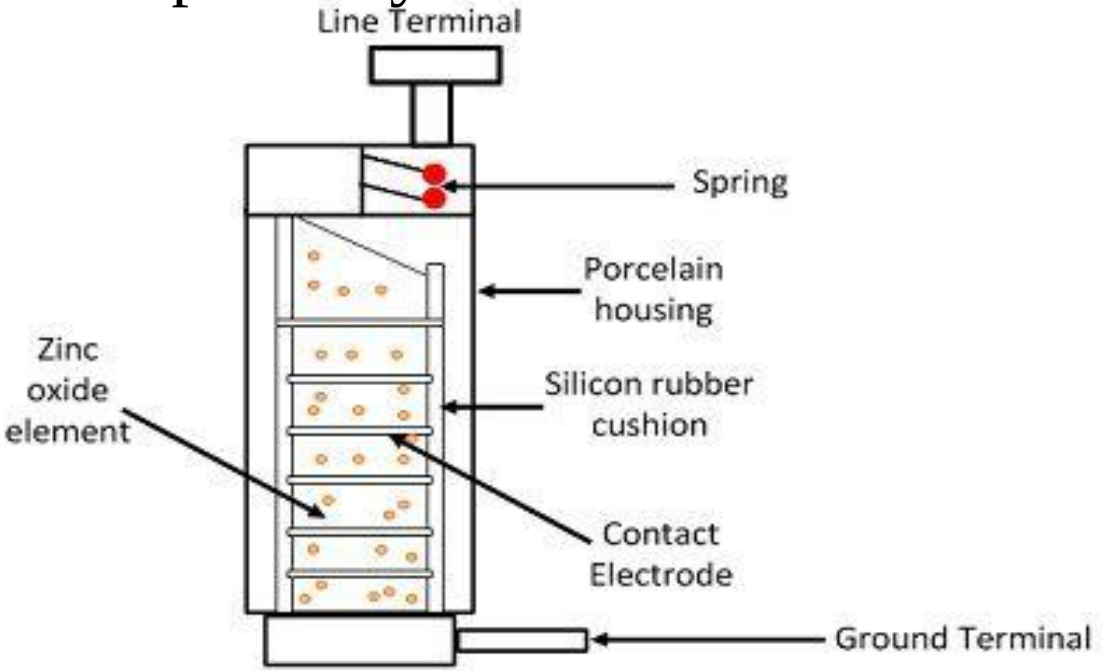
- One end of horn is connected to the line through a resistance R and choke coil L while the other end is effectively grounded. The resistance R helps in limiting the follow current to a small value.
- The choke coil is so designed that it offers small reactance at normal power frequency but a very high reactance at transient frequency. Thus the choke does not allow the transients to enter the apparatus to be protected.
- The gap between the horns is so adjusted that normal supply voltage is not enough to cause an arc across the gap.

WORKING

Under normal conditions, the gap is non-conducting i.e. normal supply voltage is insufficient to initiate the arc between the gap. On the occurrence of an overvoltage, spark-over takes place across the small gap G. The heated air around the arc and the magnetic effect of the arc cause the arc to travel up the gap. The arc moves progressively into positions 1, 2 and 3. At some position of the arc (perhaps position 3), the distance may be too great for the voltage to maintain the arc. Consequently, the arc is extinguished. The excess charge on the line is thus, conducted through the arrester to the ground.

METAL OXIDE SURGE ARRESTER

Such type of arrester is known as gapless surge diverters or ZnO Diverter. It is mainly used for overvoltage protection at all voltage levels in a power system.



Zinc Oxide Surge Arrester

Circuit Globe

WORKING

- It is a semiconducting N-type material . The material is doped by adding some fine power of insulating oxides. This is treated with some processes and compressed into disc shaped.
- This disc is enclosed in porcelain housing filled with SF6 and nitrogen gas.
- The arrester consists of potential barriers at the boundaries of each disc of ZnO.
- At normal operation it does not allow the current to flow . when overvoltage occurs barrier collapse and sharp transition takes place.
- The current starts flowing and surge diverted to ground.

QUERIES ?