9-Neutral Earthing (Grounding)

Neutral earthing: is connecting to earth the neutral point.

Neutral grounding is important because the following:

1-The earth fault protection is based on the method of neutral earthing.
2-The system voltage during earth fault depends on neutral earthing.
3-Neutral earthing has associated switchgear.
4-Neutral earthing is provided basically for the purpose of protection against arcing grounds, unbalanced voltages with respect to earth, protection from lightning and for improvement of the system.

Equipment earthing:
It is different from neutral earthing , equipment earthing is connecting to earth the non current carrying metallic parts.
The non current carrying metallic parts include the following:
1-Motor body- switchgear metal enclosure-transformer tank.
2-Support structures, towers, poles.
3-Sheeths of cables.
4- Body of portable equipment such as iron oven.

Equipment Earthing Ensures Safety:

The potential of earthed body does not reach to dangerously high value above earth, since it is connected to earth. Secondly, the earth fault current flows through the earthing and may readily cause operation of fuse or an earth relay.

Nature of the problem:
Consider a high voltage line connected to supply without load. even if no currents are drawn by the load, the conductors of the system continue to charge the system capacitance alternately to positive and negative polarity. The distributed capacitance between phase and earth draw charging currents from the source. The charge is given by

$$Q = CV$$

Q = charge, coulombs
C = capacitance, farads
V = voltage, volt

For high voltage system, the capacitance and the charging currents significant and the reactive KVA .

When an earth fault occurs, the distributed capacitance gets charged due to supply voltage, the charged capacitance discharges through the fault when the gab between the fault and ground break down. The capacitance again gets charged and again discharged, such repeated charging and discharging of line to ground capacitance resulting in repeated arcs between line and ground is called Arcing ground.

Arcing ground produce severe voltage oscillations reaching three to four times normally voltage. Secondly a temporary fault grows in to a permanent fault due to arcing ground, the problem of arcing ground is solved by earthing the neutral point.

9·1. Neutral Grounding. A simple undergrounded-neutral system is shown in Fig. 9·1. The line conductors have capacitances between one another and to ground, as represented by the delta and star connected sets of capacitances.

The delta sets of capacitances have little influence on the grounding characteristic of the system and will therefore be disregarded in the discussion to follow.

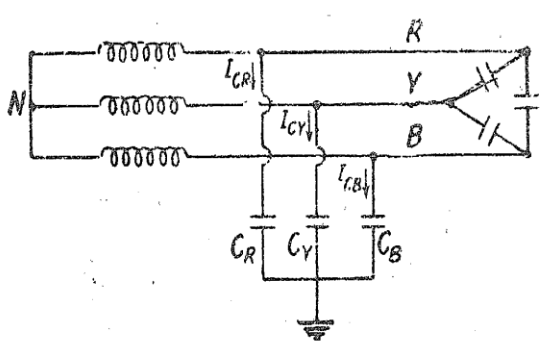

Fig. 9·1

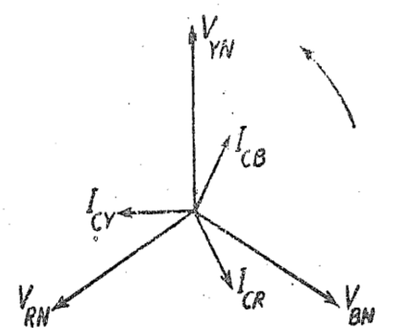

Fig. 9·2

In a perfectly transposed line, each conductor will have the same capacitance to ground. Therefore, under normal conditions, the line to neutral charging currents I_{CR}, I_{CY}, I_{CB} will form a balanced set of currents as shown in Fig. 9·2. Phasors V_{RN}, V_{YN} and V_{BN} represent the phase to neutral voltage of each phase. The charging currents I_{CR}, I_{CY}, I_{CB} lead their respective phase voltages by 90°. In magnitude each of these currents is

$$=V_{ph}/X_C \qquad \text{...(9·1)}$$

where X_C is the capacitance of the line to ground. These phasor currents balance and so no current flows to earth.

Consider now a phase to earth fault at F in line B as shown in Fig. 9·3 (a).

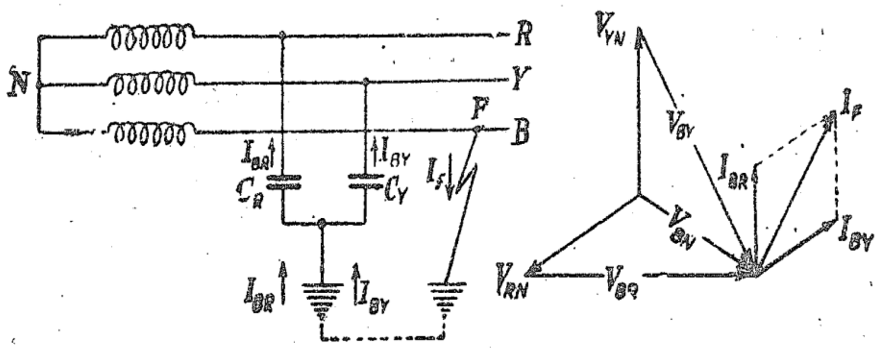

Fig. 9·3 (a) Fig. 9·3 (b)

The current in phase B has two components:

1. I_{BR} through phase B- the fault-C_R to phase R.
2. I_{BY} through phase B- the fault-C_Y to phase Y.

The voltage driving these currents are V_{BR} and V_{BY} respectively and since the impedance of the circuit traversed by these components is predominantly capacitance, they lead their respective voltage by 90^0, as shown by phasors I_{BR} and I_{BY} in fig.(9.3b)

$$I_{BR} = \frac{V_{BR}}{Xc} = \frac{\sqrt{3}V_{ph}}{Xc}$$

similarly

$$I_{BY} = \frac{V_{BY}}{Xc} = \frac{\sqrt{3}V_{ph}}{Xc}$$

The fault current is I_F the vector sum of I_{BR} and I_{BY}

$$I_F = \sqrt{3}I_{BR} = \sqrt{3}\times\sqrt{3}\frac{V_{ph}}{Xc} = 3\frac{V_{ph}}{Xc}$$

The following conclusions can be drawn from above:

- In ungrounded neutral system, under line to ground fault the voltage to earth of the two healthy phases rises from their normal phase to neutral voltage to full line value, this may result in insulation break down.
- The capacitive current in the two healthy phases increases to $\sqrt{3}$ times the normal value.
- The capacitive current in the faulty phases is 3 times its normal value.
- A capacitive current flows into earth.

The system neutral can be grounded by one of the following methods:

1. Solid or effective grounding.
2. Resistance grounding.
3. Reactance grounding.
4. arc- suppression coil or resonant grounding.