2.6.5 Negative sequence relay:

Principle

Negative sequence relays are used to protect electrical machines against overheating due to unbalance currents in stator. These unbalance currents cause heating of rotor and damage it.

Unbalance three-phase currents have negative sequence components.

✓ These components rotate at synchronous speed in a direction opposite to the direction of rotation of rotor, including double frequency currents in the rotor.

Construction and Operation:

- The arrangement of negative sequence relay connection is shown in the figure.
- The relay is connected in parallel across the current transformer secondaries.
- Under normal conditions, as equal current flows in all the three phases, their algebraic sum is zero. Hence no current flows through the relay.
- But, if unbalancing occurs, the secondary currents will be different and the resultants current flows through the relay and the operation of the relay trips the circuit breaker to disconnect the generator from the system.

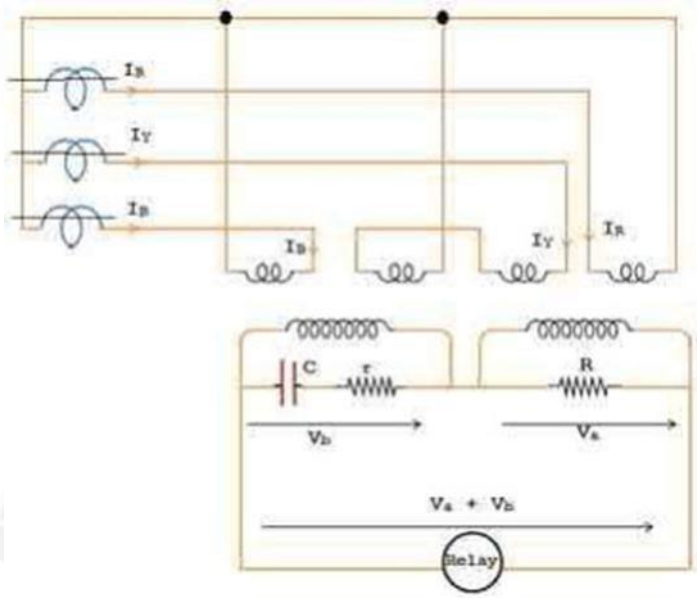

Figure: Negative sequence relay

[Source: "Principles of Powersystem" by V.K.Mehta, Page: 358]

✓ For unbalanced conditions or unsymmetrical faults, negative phase sequence network are used as shown in the figure below.

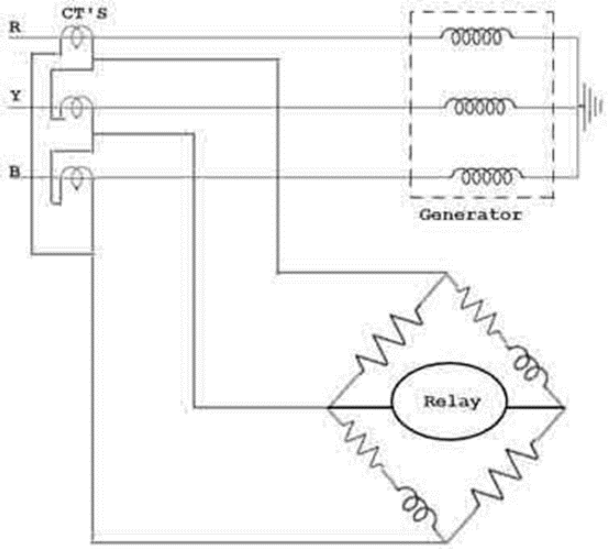

Figure: Negative sequences relay (Un balanced conditions)

[Source: "Principles of Powersystem" by V.K.Mehta, Page: 360]

- ✓ The values of c and r are such as to give a phase shift 60^{o}. It can be seen from the vector diagrams that for the positive sequence currents the output voltage $V_a + V_b$ applied to the relay is zero shown in fig-a below
- ✓ Where for the negative sequence currents, the output voltage $V_a + V_b$ is of considerable magnitude to operate the relay shown in fig-b.

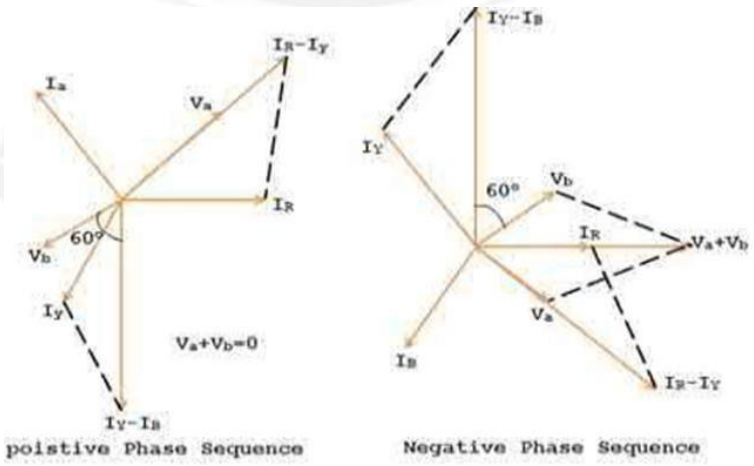

Figure: Pharos diagram of positive and Negative phase sequence relay

[Source: "Principles of Powersystem" by V.K.Mehta, Page: 364]

The negative sequence relay has the inverse square law characteristic. i.e., $I_2^2 t = K$, a constant. I_2 is the negative sequence component to the current

$$t = K / I_2^2 \text{ i.e., } t \alpha 1/I_2^2$$

2.6.6. Under Frequency Relay

The frequency relays are normally used in generator protection and for load-frequency control.

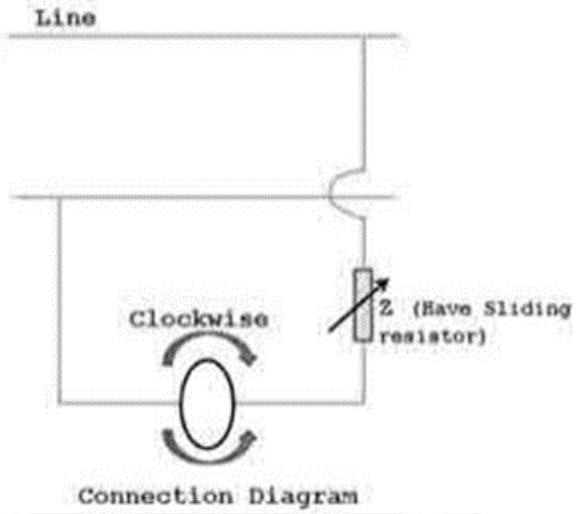

Figure: Under Frequency Relay

[Source: "Principles of Powersystem" by V.K.Mehta, Page: 369]

- The frequency of induced e.m.f. of synchronous generator is maintained constant by constant speed. Over speeding of the generator occurs due to loss of load and under speeding occurs due to increase in load.
- In both the cases, the frequency varies from normal value. In order to avoid damage to the generator under the above two conditions, frequency relays are used.
- Under frequency relay trips the feeder on load at set value of frequency, so as to give relief to the generator, thereby saving the unit. Under frequency relay thus aids load shedding programme to save the grid.