4.2 Phase, Amplitude Comparators

4.2.1 Comparator

- The magnitude of voltage & current and phase angle between them may change when a fault occurs.
- Static relay senses the change in these parameters to differentiate between healthy and faulty conditions.
- This is achieved by comparing either the magnitudes of voltage &current or the phase angle between them.
- The circuitry which performs this function is called comparator.

4.2.2 Types of Comparator

1. Amplitude comparator
2. Phase comparator

4.2.2.1 Amplitude Comparator

- It compares the magnitude of two input quantities irrespective of the angle between them.
- The two quantities are operating quantity and restraining quantity.
- When the magnitude of the operating quantity is greater than the restraining quantity, the relay sends trip signal to C.B.

Types of Amplitude Comparator:

a) Circulating current comparator

- i_O and i_r are operating and restraining currents.
- Under no fault condition, $i_r > i_O$. The differential current flows through the relay in -ve direction.
- During a fault, $i_o > i_r$. Hence the differential current flows through the relay in +ve direction to trip C.B

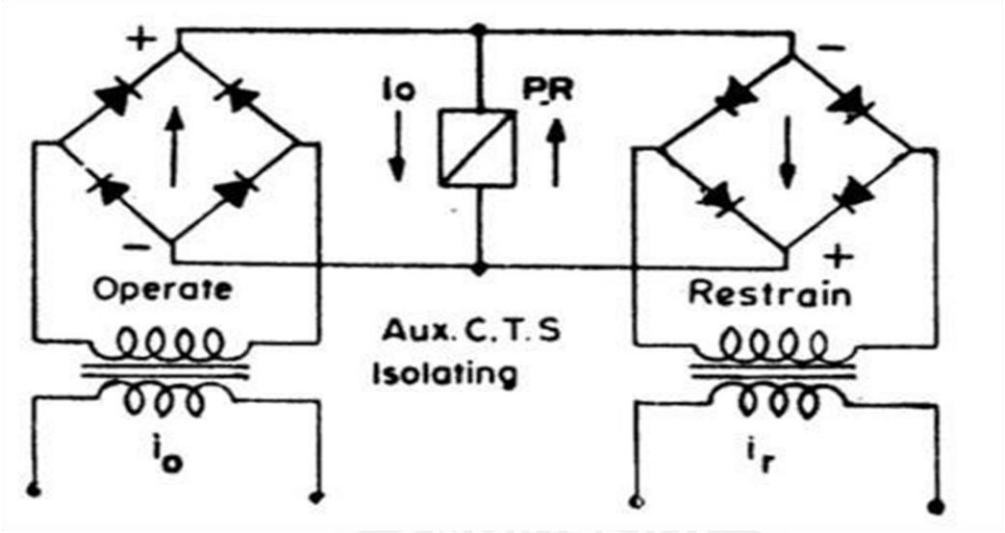

Figure 4.2.1 Diagram of circulating current comparator

[Source: "Power System Protection and Switchgear'" by B.Rabindranath and N.Chander, Page: 428]

b) Opposed Voltage Comparator:

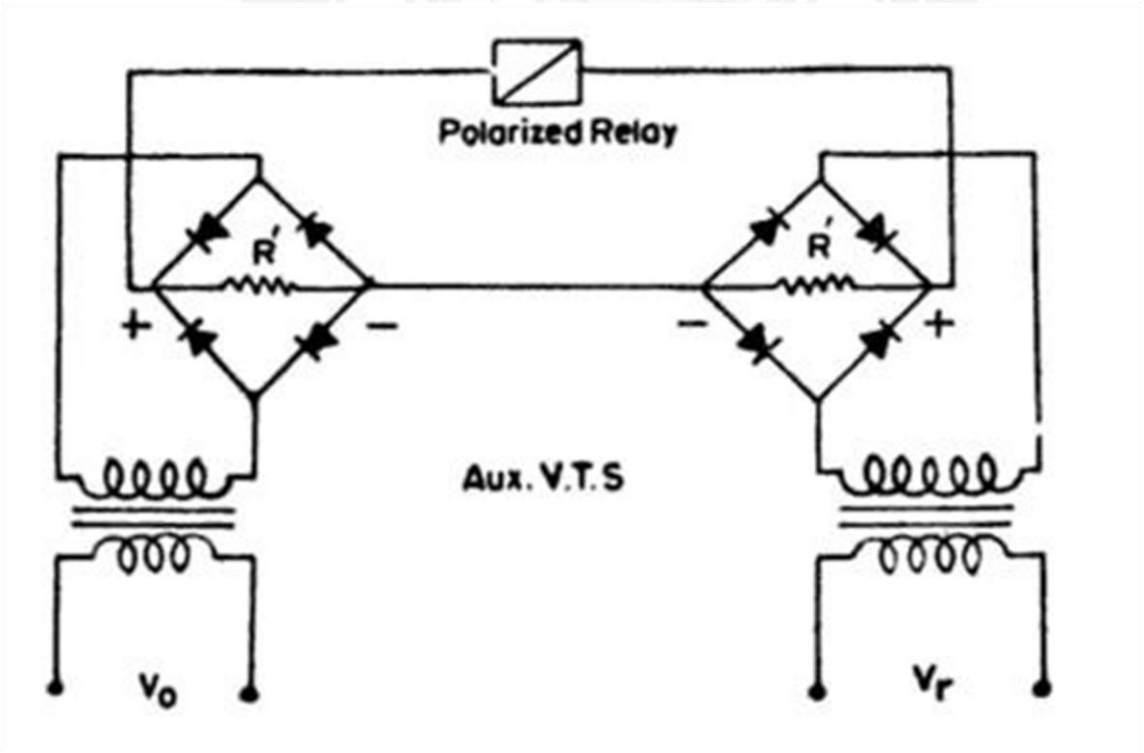

Figure 4.2.2 Diagram of opposed voltage comparator

[Source: "Power System Protection and Switchgear'" by B.Rabindranath and N.Chander, Page: 429]

- V_O and V_r are operating and restraining voltages.
- Under no fault condition, $V_r > V_O$. The differential current flows through the relay in -ve direction.
- During a fault, $V_o > V_r$. Hence the differential current flows through the relay in +ve direction to trip C.B.

4.2.2.2 Phase Comparator:

- Period of coincidence of +ve polarity of 2 signals are compared with a reference angle. (usually 90 degree).
- If the 2 signals have a phase difference of ϕ, then the angle of coincidence $\psi = 180 - \phi$.
- If $\phi < 90^0$, then $\psi > 90^0$. The phase comparator of the C.B will open , when $\psi > 90^0$.

Types of Phase Comparator

a) Block and Spike Phase Comparator:

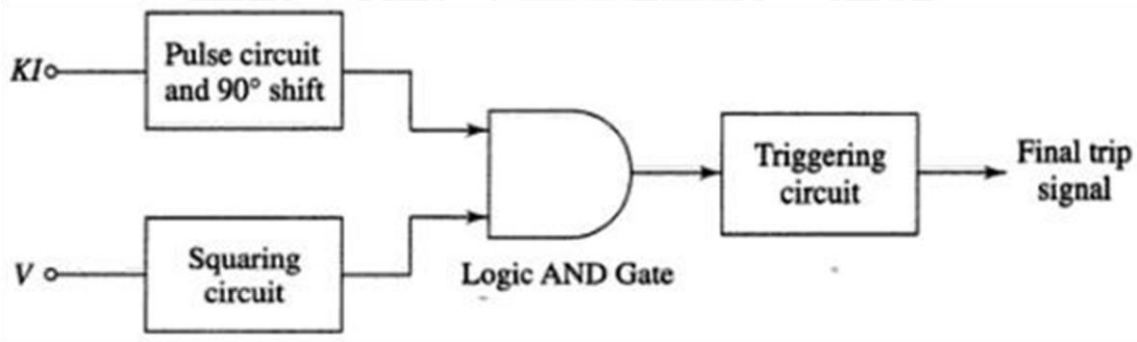

Figure 4.2.3 Block diagram of Block and Spike Phase Comparator

[Source: "Power System Protection and Switchgear'" by B.Rabindranath and N.Chander, Page: 431]

- In this method, one of the two input signals is converted into a square wave and the other is converted into a spike during its peak.
- Square wave and spike are given to an AND gate whose output is 1 when both square wave and spike are coinciding.
- Coincidence will happen only when the angle between the input signals are less than 90^0 which indicates a fault.
- Output of AND gate is used to trip the C.B.

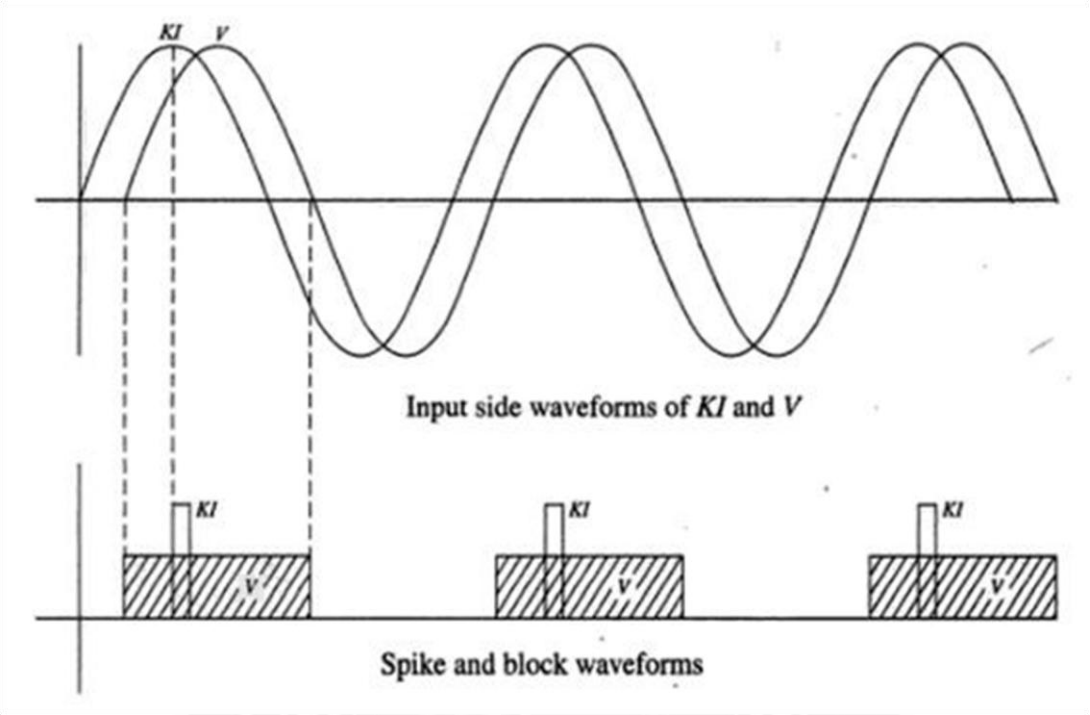

Figure 4.2.4 Wave form of Block and Spike Phase Comparator

[Source: "Power System Protection and Switchgear'" by B.Rabindranath and N.Chander, Page: 432]

b) Phase Splitting Comparator

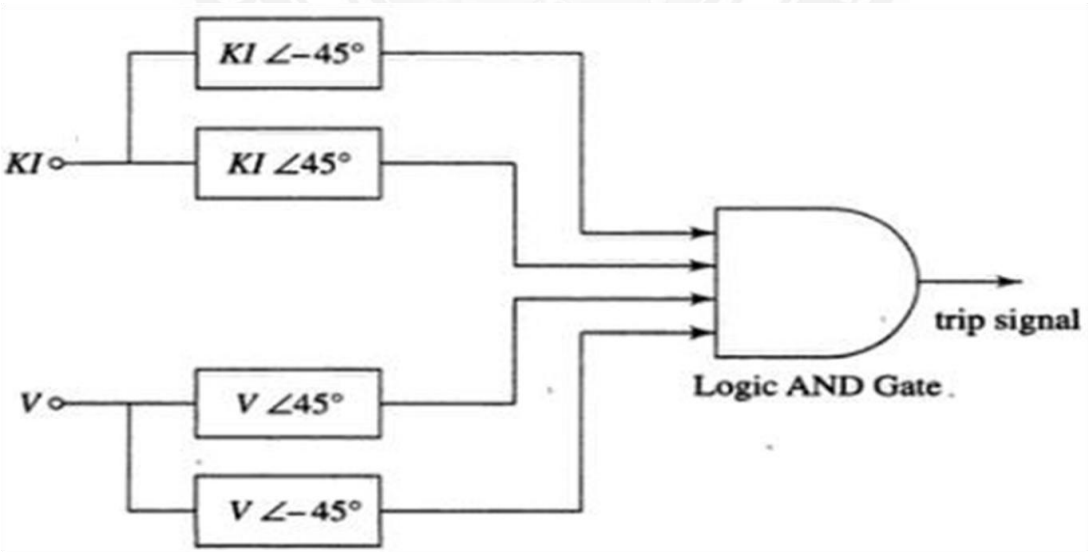

Figure 4.2.5 Block diagram of Phase Splitting Comparator

[Source: "Power System Protection and Switchgear'" by B.Rabindranath and N.Chander, Page: 434]

- In this method, two phase shifted (+/-45^0) components are obtained for each of the input signals.
- These 4 components are fed into an AND gate.

- Output will be 1 if all 4 signals are positive at a time. This happens only during a faulty condition.
- Output of AND gate is used to trip the C.B.

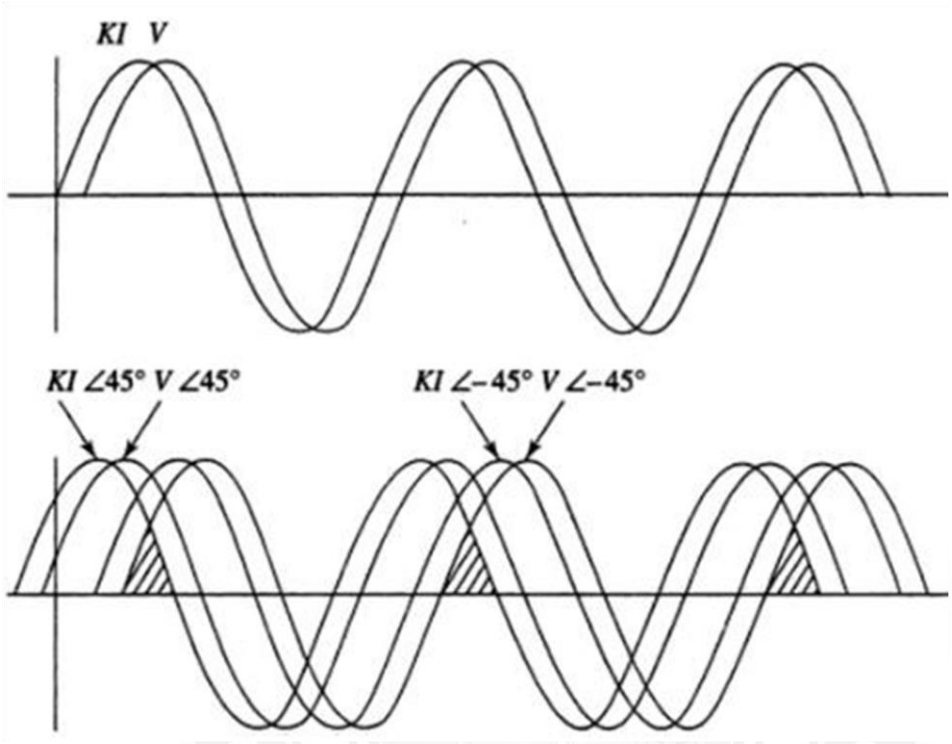

Figure 4..2.6 Wave form of Phase Splitting Comparator

[Source: "Power System Protection and Switchgear'" by B.Rabindranath and N.Chander, Page: 435]