

# Differential Protection Relay

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# Differential Protection Relay

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- A differential relay is defined as the relay that operates when the phase difference of two or more identical electrical quantities exceeds a predetermined amount.
- The differential relay works on the principle of comparison between the phase angle and magnitude of two or more similar electrical quantities.
- Comparing two electrical quantities in a circuit using differential relays is simple in application and positive in action.



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- Comparing two electrical quantities in a circuit using differential relays is simple in application and positive in action.
  - Differential protection provides unit protection. The protected zone is exactly known by the location of current and potential transformers. The phase difference is achieved by suitable connections of secondaries of CTs and PTs.

# Type of differential relay

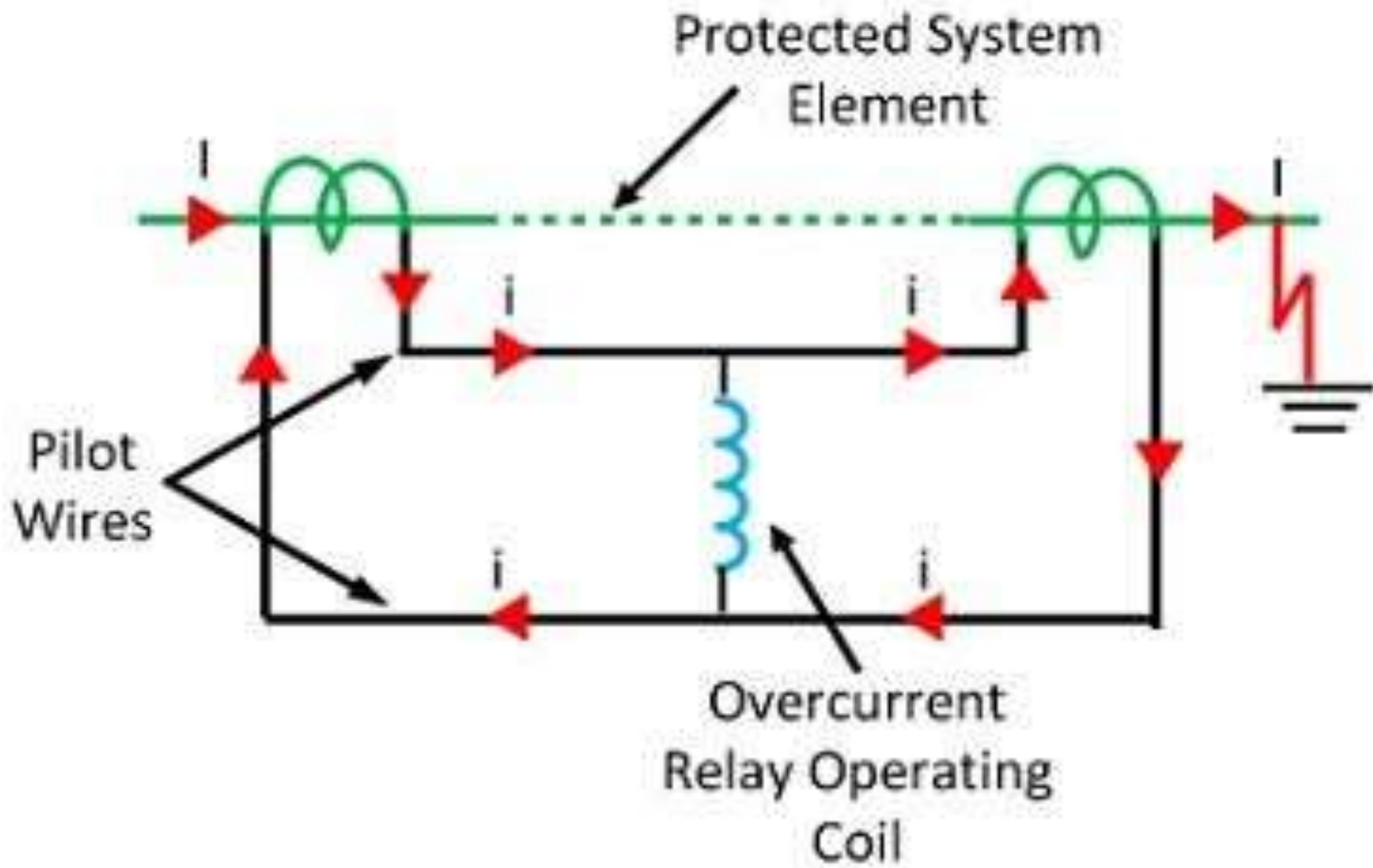
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- The differential protection relay is mainly classified into four categories. These are
  - Current Differential Relay
  - Voltage Differential Relay
  - Biased or Percentage Differential Relay
  - Voltage Balance Differential Relay

# Current Differential Relay

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- A relay which senses and operates the phase difference between the current entering into the electrical system and the current leaving the electrical system is called a current differential relay.
- An arrangement of overcurrent relay connected to operate as a differential relay is shown in the figure below.



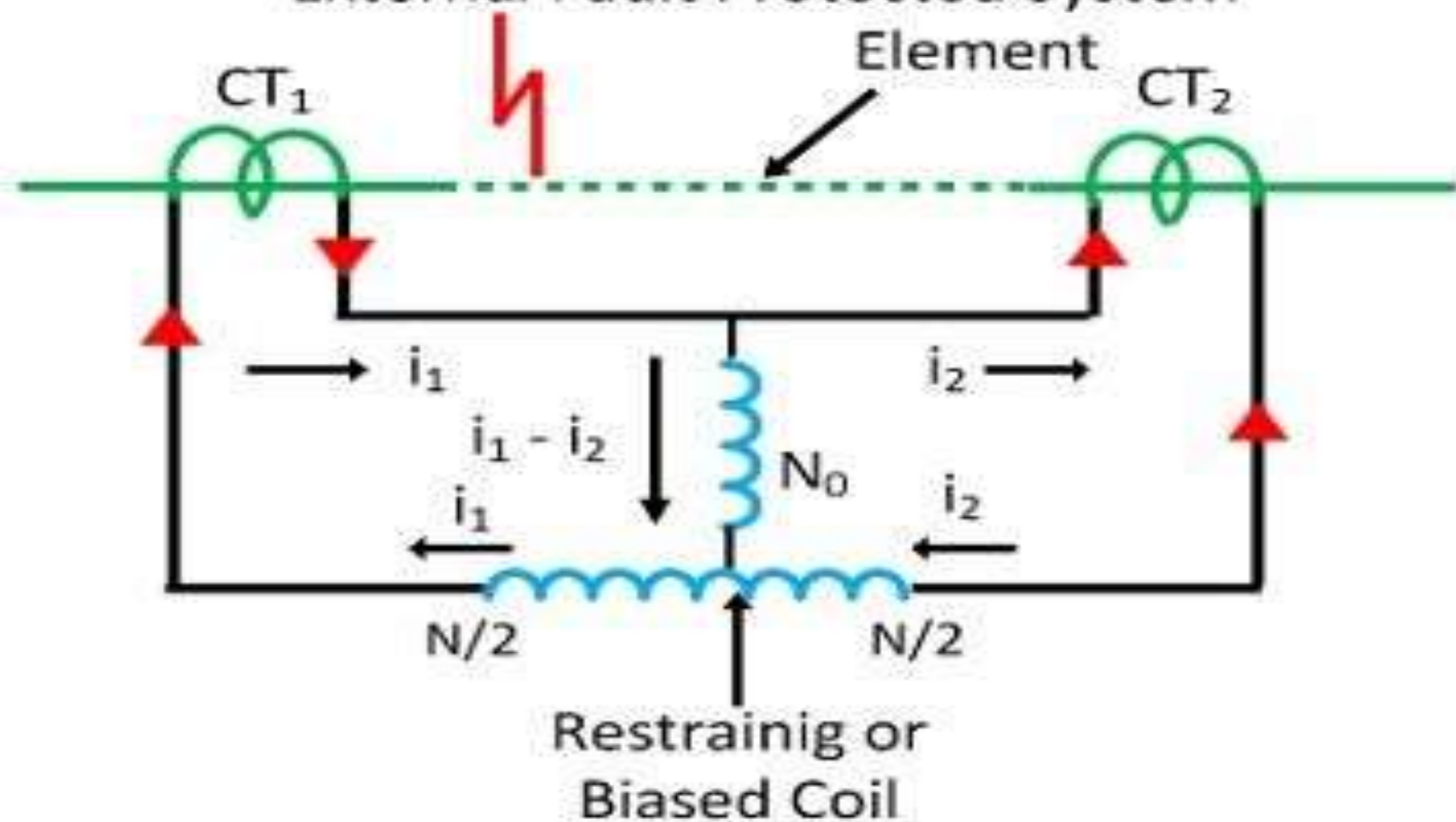
**For an External Load or Fault**

# Biased or Percentage Differential Coil

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- This is the most used form of differential relay. Their arrangement is same as that of the current differential relay; the only difference is that this system consists an additional restraining coil connected in the pilot wires as shown in the figure below and current flows in both CTs flows through it.

## External Fault Protected System Element

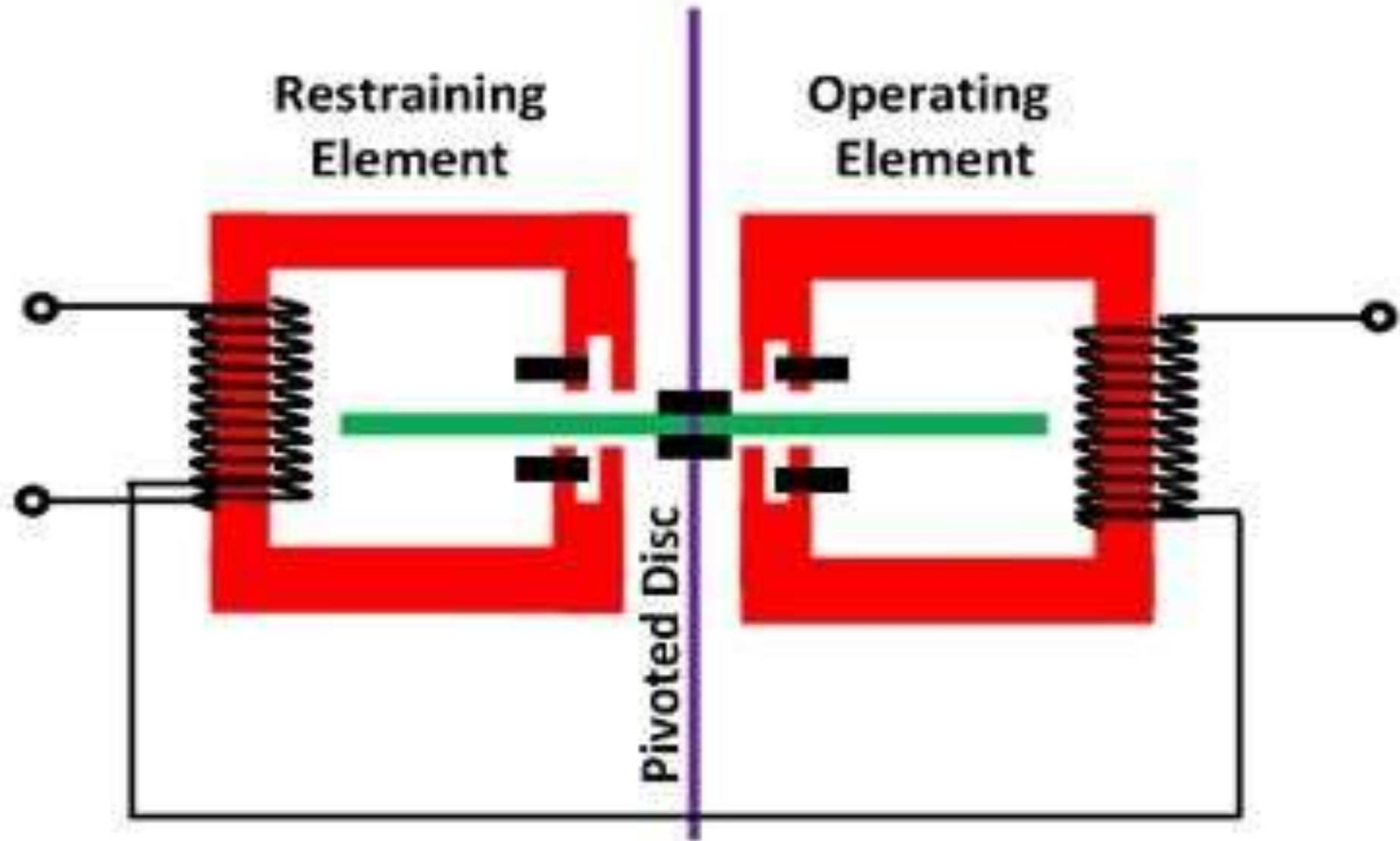


## Biased or Percentage Differential Relay

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- The operating coil is connected to the midpoint of the restraining coil.
  - The reasons for this modification in circulating current differential relay is to overcome the difficulty arising out of differences in current transformers ratio for high values of short circuit current.

# Induction Type Biased Differential Relay

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- This relay consists of a pivoted disc free to rotate in the air gaps of two electromagnets. The portion of each pole of the electromagnet magnet is fitted with a copper shading ring. The ring can be moved further in, or out of the pole. The disc experiences two torques one due to operating element and other due to restraining element.

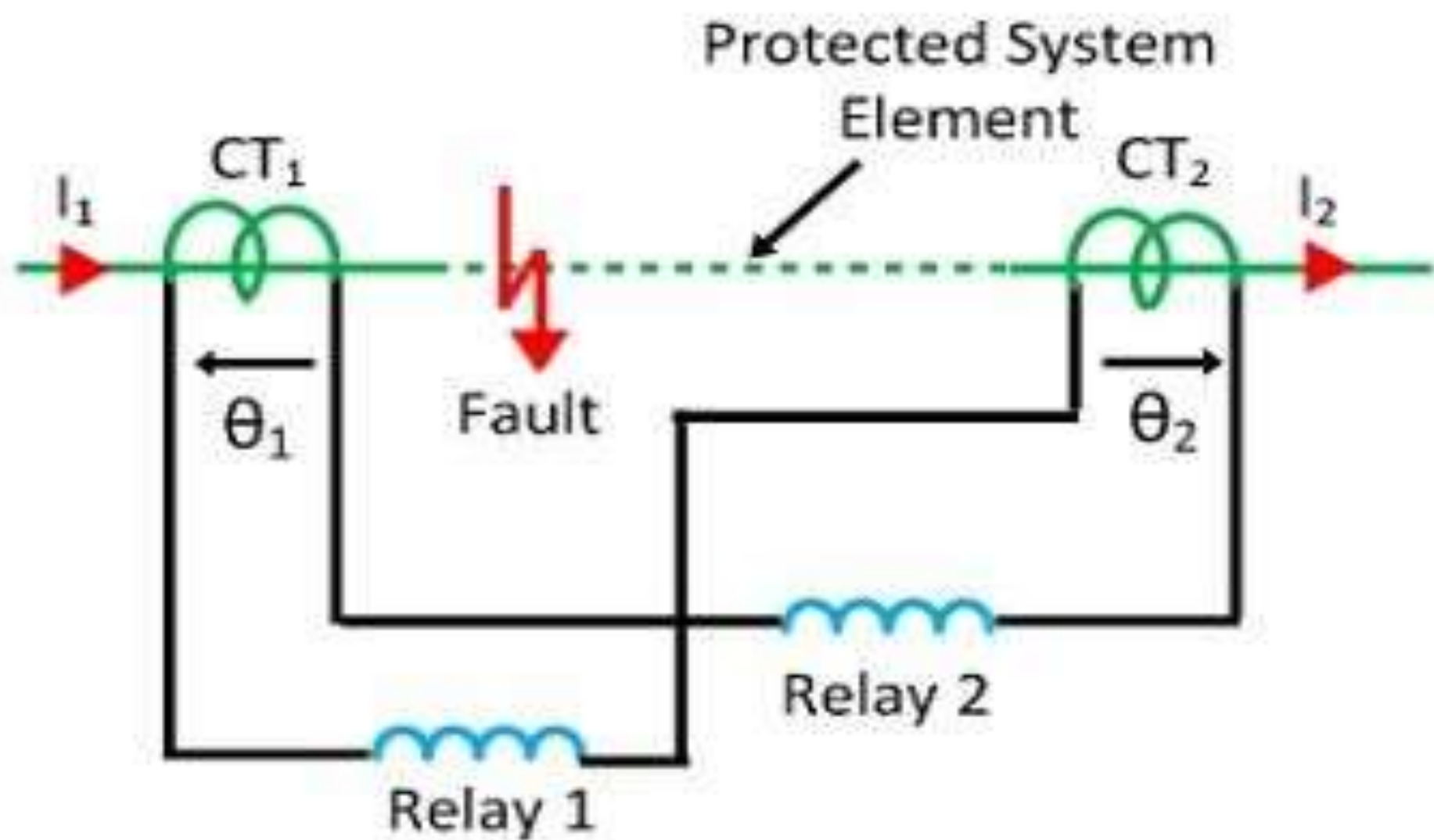


**Induction Type Biased Differential Relay**

# Voltage Balance Differential Relay

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- The current differential relay is not suitable for the protection of the feeders.
- For the protections of the feeders, the voltage balance differential relays are used. In this arrangement, the two similar current transformers are connected at either end of the system element under protection using pilot wires.



**Balance Voltage Differential Protection**

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- The relays are connected in series with the pilot wires, one at each end.
  - The relative polarity of the current transformers is such that there is no current through the relay under normal operating conditions and under fault conditions.
  - The CTs used in such protections should be such that they should induce voltages in the secondary linearly with respect to the current.
  - Since the magnitude of the fault current is very large, so that the voltage should be a linear function of such large currents, the CTs should be air-cored.

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- When the fault occurs in the protected zone, the currents in the two primaries will differ from one another, and so voltage induced in the secondaries of the CTs will differ and circulating current will flow through the operating coils of the relays. Thus the trip circuit will be closed, and the circuit breaker will be open.

# Advantages of Relay

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- The advantage of this relay is that it is less likely to operate incorrectly than a differentially connected overcurrent relay when a short circuit occurs external to the protected zone.
- This relay has a unique advantage of reducing the time of operation to a minimum for faults very close to the source where the fault current is the greatest.

