Protective Relays

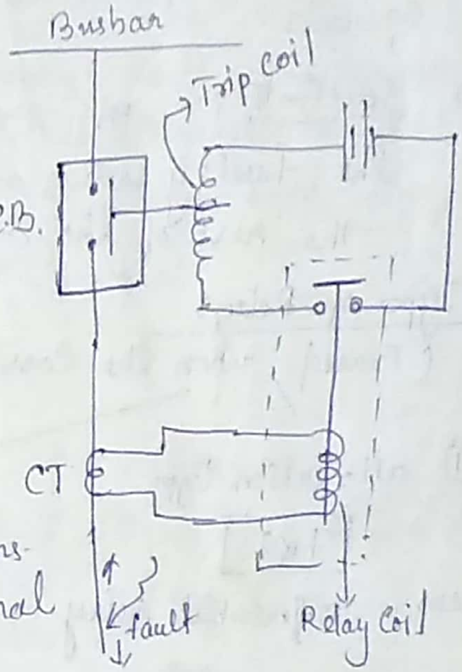
U.C.P. ENGG SCHOOL
BERHAMPUR, (GANJAM)

BRANCH..........
Semester..........
Roll No./ Regd No..........
Date..........

Relay :- It is a Protective device which Sense/detect the unbalance/fault Condition and gives the Command to the Circuit Breaker.

Working Principle:

Before fault



→ At normal condition, the Secondary voltage of CT at Relay coil is insufficient to energizes the Relay coil. So the Relay is unable to Close the Circuit of Breaker. So moving Contact of Breaker get closed to the Trans-mission Line and Carry Normal Current.

After fault

→ When fault occur, the high amount of current flow through the primary of CT, which Lead to Produce the high voltage across the Secondary of the CT that so high voltage is Sufficient to energizes the relay coil and that close the Circuit of Breaker. Through the DC excitation, the trip coil get energized and Separate the contact of CB.

Characteristics of Relay

1. **Sensistivity :—** Relay is able to Producing sufficient Power to operate with minimum fault current.

2. **Speed :—** The relay system Sould operate as ~~soon~~ fast as possible to dissconnect the healthy part from faulty Part.

Scanned with CamScanner

(iii) Economy :- The cost of Protective relays should be the less than 20% cost of device which is to be protected.

(iv) Simplicity :- relay structure should be should be simple so that it can be easily maintained.

(v) Reliability :- Under unbalance condition Relay must be operate and under normal operating condition relay should not operate.

(vi) Selectivity :- It should have the ability to select the faulty section and disconnect it without affecting the rest of the system.

Types of Relays
(Based upon the construction)

① attraction type

$T \propto I$

exp - Differential relay.

② Induction type

$T \propto I^2$

exp :- Distance relay

Electromagnetic Relay :- Electromagnetic relays are those relay which operates on the principle of electromagnetic. It is a type of a magnetic switch which uses the magnet for creating a magnetic field. The magnetic field then uses for opening and closing the switch ~~and for~~ opening ~~and~~ closing the switch, and for performing the mechanical operation

Types of Electromagnetic Relays

Based on the working Principle, the electromagnetic relay is mainly classified into two types

1. Electromagnetic attraction type
2. Electromagnetic induction type

Electromagnetic attraction type

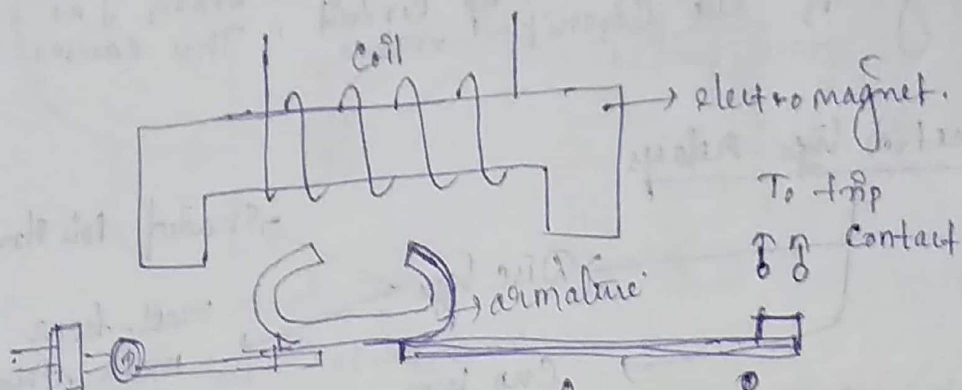
→ In this relay, the armature is attracted towards the pole of a magnet. The electromagnetic force exerted on the moving element

→ These relays are operate in both AC & DC value.

→ 3 types.

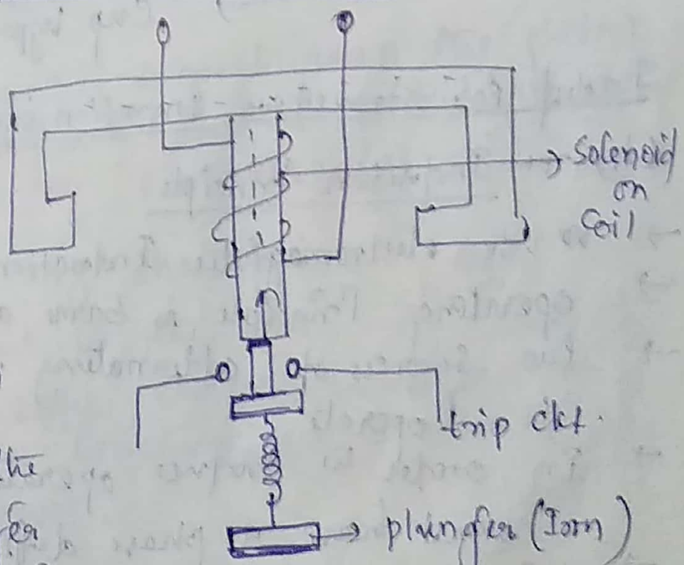
① attracted armature type relay

→ In these relays, there is a coil which energizes an electromagnet.
→ when operating current becomes large, the magnetic field produced by an electromagnet is so high that it attract the arm armature making contact with trip contact
→ Then the trip ckt get closed.



② Solenoid type relay

→ It works on the principle of electro-magnetic attraction.
→ It consists of a solenoid which is nothing but an electromagnet.
→ It also consists of the movable Iron plunger.

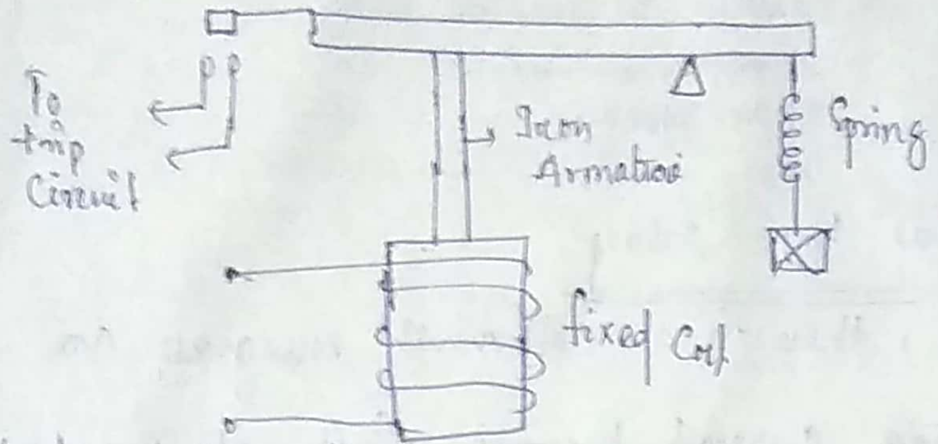


Working under Normal Condn

under Normal condn, the spring holds plunger in the position such that it can't make the contact with trip circuit.

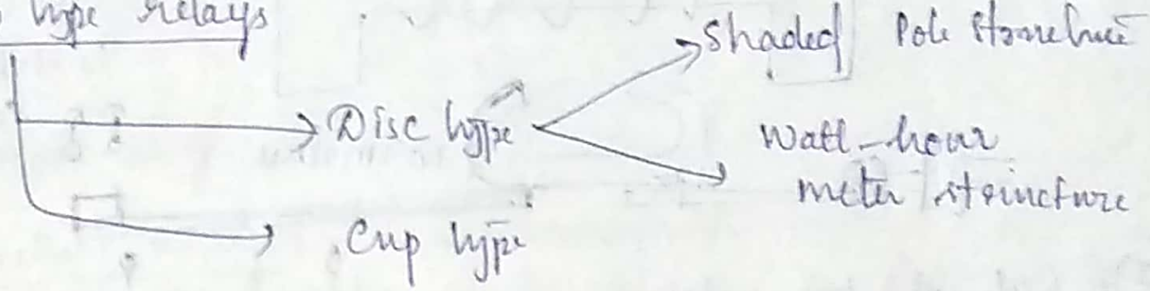
under fault condn :- Under fault condn when the current through the relay coil increases the solenoid draws the plunger upwards. Due to this it makes contact with the trip circuit.

(iii) Balanced beam type relay



Under normal operating conditions, the current through the relay coil is such that the beam is held in the horizontal position by spring. When fault occurs, the current through the relay coil becomes greater than the pick-up value and the beam is attracted to close the trip circuit. This causes opening of the Circuit Breaker.

Induction type relays



Shaded pole structure Induction type relays

Induction Principle

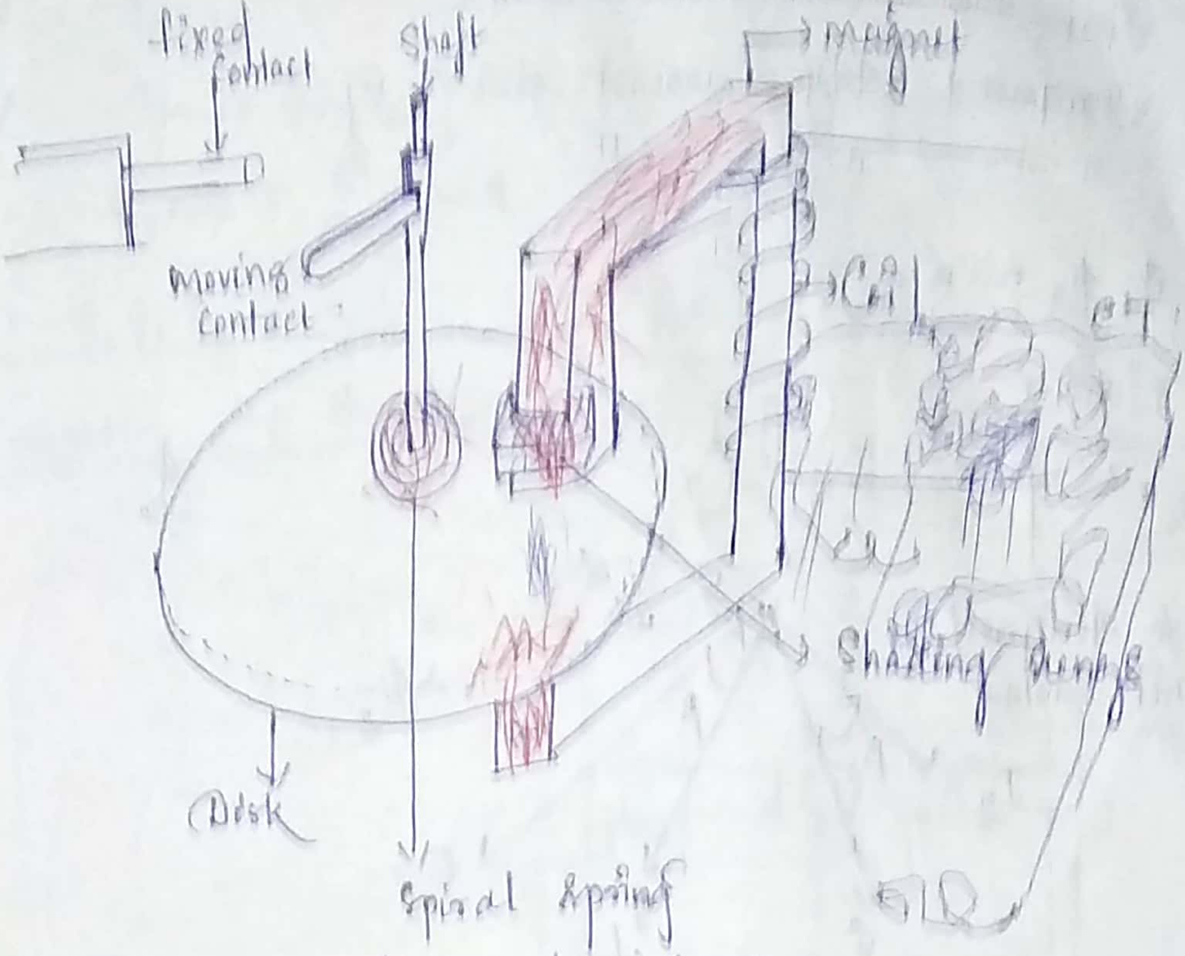
→ Use electromagnetic Induction Principle

→ operating Principle is same as that of 1ϕ IM.

→ two sources of alternating magnetic flux are required to operate

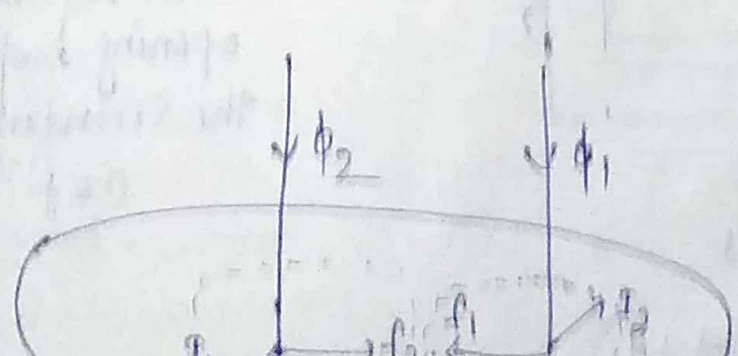
→ In order to produce operating torque, these 2 fluxes must have a phase difference betⁿ them.

→ Can be used only for AC.



Rotating spiral disc = aluminium
C shaped electromagnet.

→ ~~The~~ when current in Coil is greater than the pickup current then the Due to electromagnetic induction one flux is generated by electromagnet and (ϕ_1)
another flux generate by shading ring (ϕ_2)
These two mmf are cut in the disc and lead to produce the two eddy current in disc.
Then operating torque is produced in disc due to the interaction of two current.



ϕ_2 = flux in shaded portion

ϕ_1 = flux in unshaded portion (Electromagnet)

E_1 = EMF induce in disc due to ϕ_1

E_2 = EMF " " " ϕ_2

I_1 = Induced eddy current due to E_1

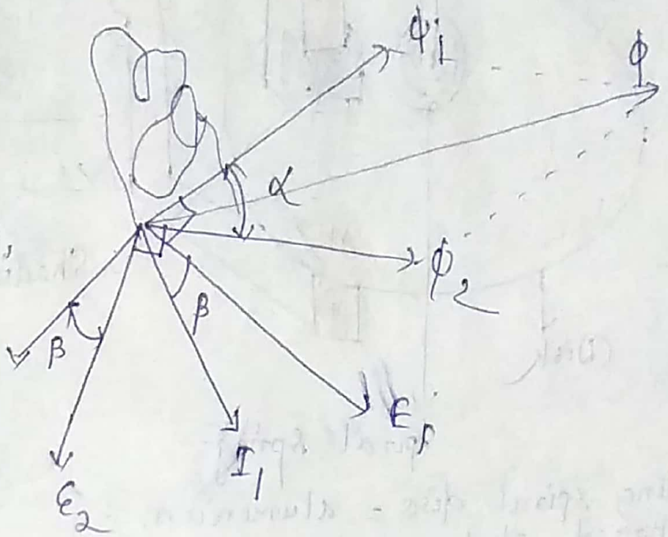
I_2 = " " " " E_2

$T \propto \phi_1 \phi_2 \sin\alpha$.

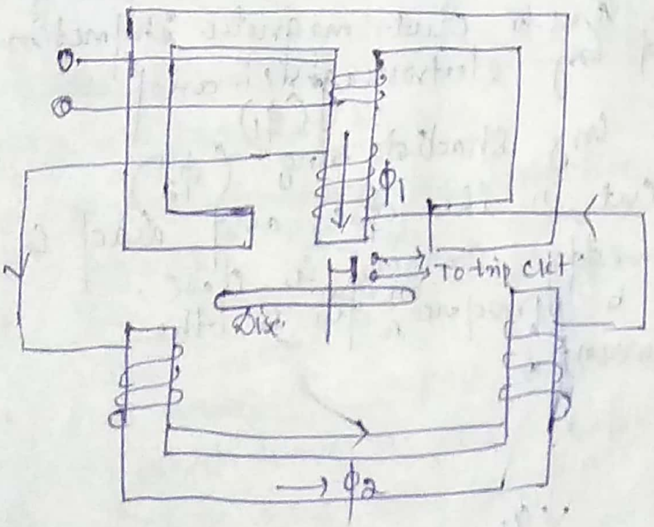
$T = I^2 \sin\alpha$

$$\boxed{T = kI^2}$$

once the m/c designed, the $\sin\alpha$ will constant.



Watt hour meter type relay



E & U shaped electromagnets

- Torque $\propto \phi_1 \phi_2 \sin\alpha$
- The flux induced in upper and lower magnetic differ in phase by angle α.
- Operation can be controlled by opening and closing the secondary winding ckt.

Let $\phi_1 = \phi_{m1} \sin \omega t$

$\phi_2 = \phi_{m2} \sin(\omega t + \alpha)$

$i_1 = N_1 \dfrac{d\phi_1}{dt} = kN_1 \phi_{m1} \cos \omega t$ $\quad i_2 = k\phi_{m2} \cos(\omega t + \alpha)$

Net torque (T)

Net force (F) $= f_1 - f_2$

$= \phi_1 i_2 - \phi_2 i_1$

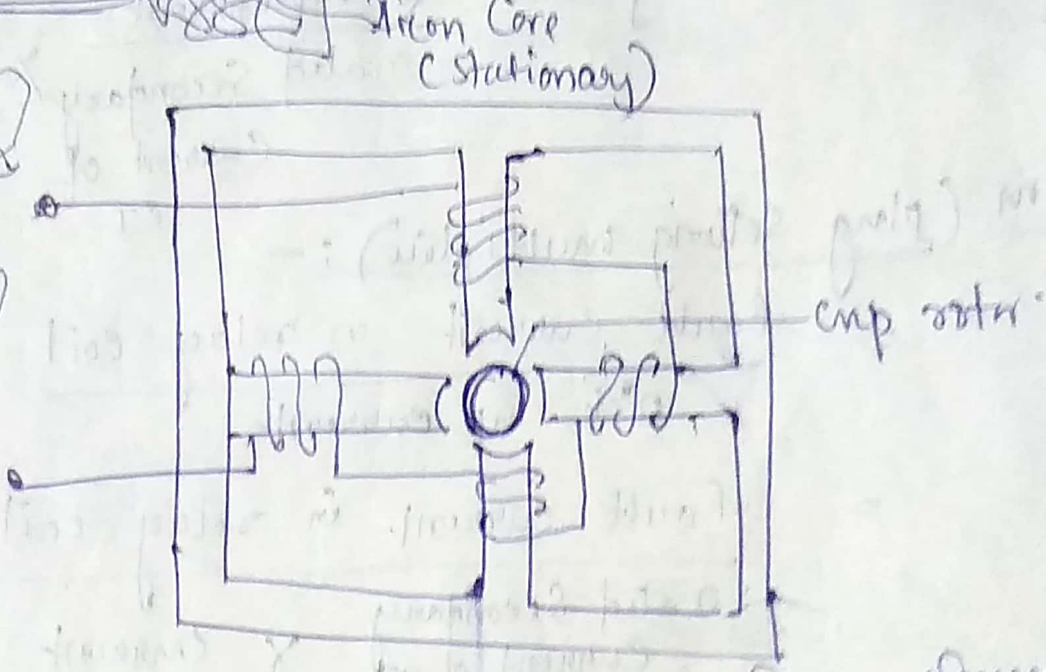
$F = \phi_{2max} \sin(\omega t + \alpha) \phi_{1max} \cos\omega t - \phi_{1max} \sin\omega t \, \phi_{2max} \cos(\omega t + \alpha)$

$= \phi_{1max} \phi_{2max} [\sin(\omega t + \alpha) \cos\omega t - \sin\omega t \cos(\omega t + \alpha)]$

$= \phi_{1max} \phi_{2max} \sin\alpha$

$$F \propto \phi_1 \phi_2 \sin\alpha$$

Induction Cup structure



The coil which is wound on the electromagnet generates the rotating magnetic field. Because of the rotating magnetic field, the current induces inside the cup. Thus the cup start rotating.

The more torque is produced in the induction cup relay as compared to the shaded and wattmeter type relay. The relay is fast in operation and their operating time is very less approximately 0.01 sec.

pickup current :– The minimum current for which the relay initiates its operation is called pick up current of relay.

Current Setting of relay:-

practically same model relays may be used in different system. As per these system requirements, the pickup current of relay is adjusted. This is known as the current setting of the relay.
This is achived by providing the required number of tapping in the coil.

Current Setting of relay expressed in percentage value

$$\text{Current setting} = \frac{\text{Pick up Current}}{\text{rated Secondary Current of CT}} \times 100 .$$

PSM (plug setting multiplier) :–

$$= \frac{\text{fault current in relay coil}}{\text{pick up current}}$$

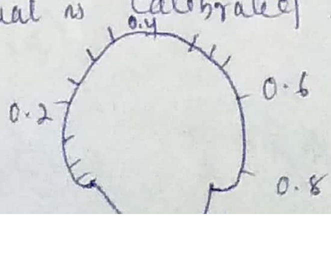
$$= \frac{\text{fault current in relay coil}}{\text{rated Secondary Current of CT} \times \text{current Setting}}$$

TSM (Time Setting multiplier) :–

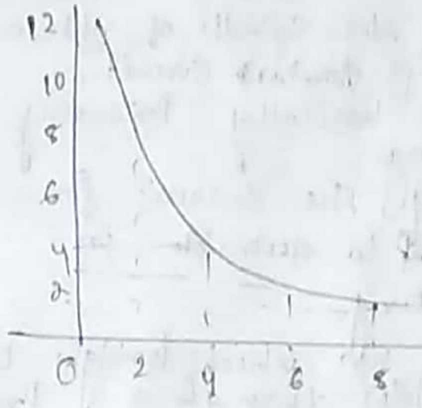
The operating time of an electrical relay mainly depends upon two factors:-

1. How long distance to be traveled by the moving parts of the relay for closing relay contact
2. How fast the moving parts of the relay cover this distance.

So far by adjusting relay operating time, both of the factors to be adjusted. The adjustment of traveling distance of an electromechanical relay is commonly known as time setting. This adjustment is commonly known as time setting multiplier.
The time setting dial is calibrated from 0 to 1 in steps of 0.05 sec.



Time Vs P.S.M Curve

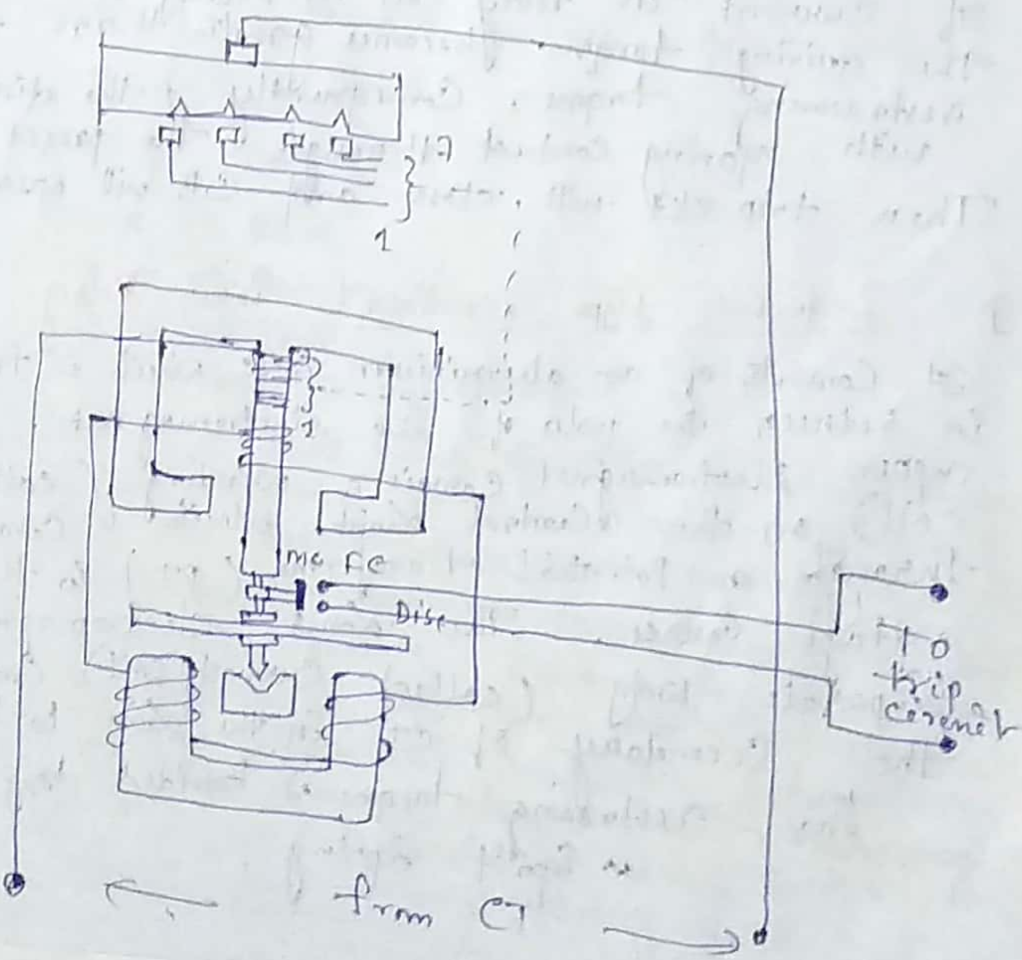


Actual relay operating time = Operating time from PSM graph × Setting time Multiple

Types of Relay based on their function

1. Induction type Overcurrent relays
2. Induction type reverse Power relays
3. Distance relays
4. Differential relays
5. Translay Scheme.

Induction type Ov. Current Relay :- (Non directional)



pic Construction:

Two electromagnet Present in between a disc is Present. Moving Contact is attached with the Spindle of disc and a FC is attach with the trip Control Circuit.

Two windings are Present here basically Primary winding and Secondary winding.

primary wdg of relay is Carry the current form CT and tapping is done due to desirable in variation of Current Setting.

The Spindle of the disc carries a m/p which bridges two fixed contacts when the disc rotates through a Preset angle. This angle Can be adjusted to any value between 0° and 360°. By adjusting this angle, the travel of the moving contact Can be adjusted and hence the relay can be given any desired time Setting.

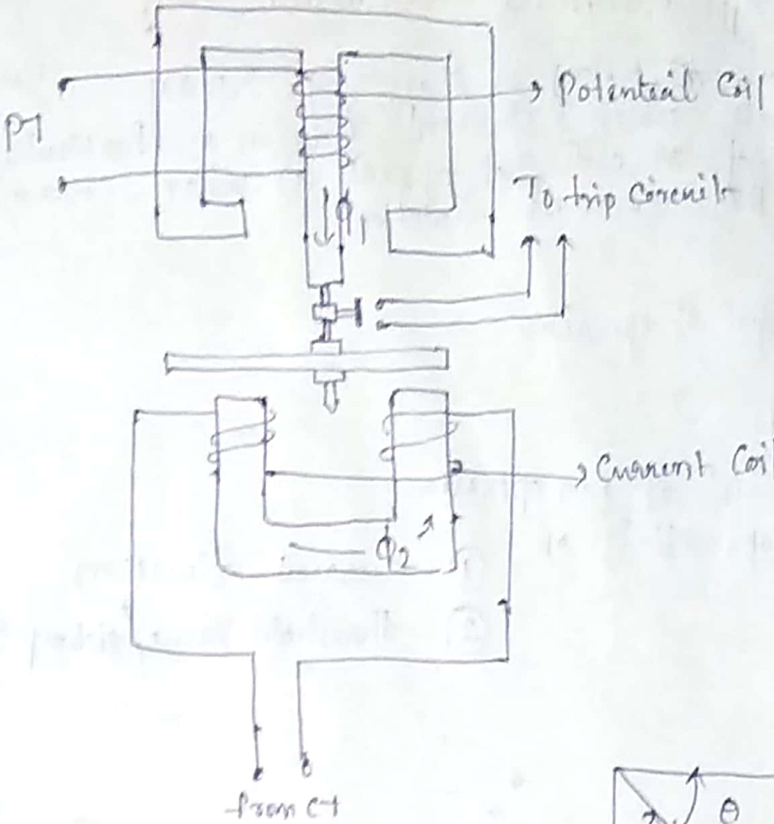
P: operation :-

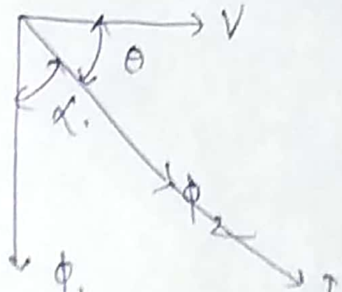
The driving torque on the aluminium disc is Set up due to the Induction Principle. The torque is opposed by the restraining torque Provided by the Spring. Under Normal operating conditions, restraining torque is greater than driving torque produce by the relay coil current. Therefore at disc remains stationary. If current in relay coil is exceed the Preset value, the driving torque becomes greater than the restraining torque. Consequently, the disc rotates with moving contact through the preset angle. Then trip ckt will close and CB will operate.

Induction type Directional Power Relay

It Consists of an aluminium disc which is free to rotate in between the poles of two electromagnet. The upper electromagnet Carries a winding (called Potential Coil) on the Central Limb which is Connected through a Potential transformer (PT) to the Circuit voltage Source. The Lower electromagnet has a Separate wdg (called Current Coil) Connected to the Secondary of CT in the Line to be Protected.

The restoring torque is Provided by the Spiral Spring.





The interaction of flux ϕ_1 and ϕ_2 with the eddy currents induced in the disc produces a driving torque.

$$T \propto \phi_1 \phi_2 \sin \alpha .$$

Since $\phi_1 \propto V$, $\phi_2 \propto I$

$$T \propto VI \sin \alpha$$

$$T \propto VI \sin (90 - \theta)$$

$$T \propto VI \cos\theta$$

$\propto$ power in the circuit

From above eqn it is clear that direction of driving torque depend on the direction of power flow in the circuit. When power in the circuit flows in the normal dirn, the driving torque and restraining torque help each other to turn away the moving contact from the fixed contacts. Consequently, the relay remains inoperative during abnormal condition, when current reverse, the driving torque also reverse and disc will rotate towards the fixed contact and fixed contact gets closed.