BASIC ELECTRICAL ENGINEERING

UNIT - 5

ELECTRICAL INSTALLATIONS

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FUSE

- Safety device
- Short piece of metal inserted in circuit which melts when excess current flows through it
- Inserted in series; breaks circuit when high current flows
- Principle: heating effect of electric current

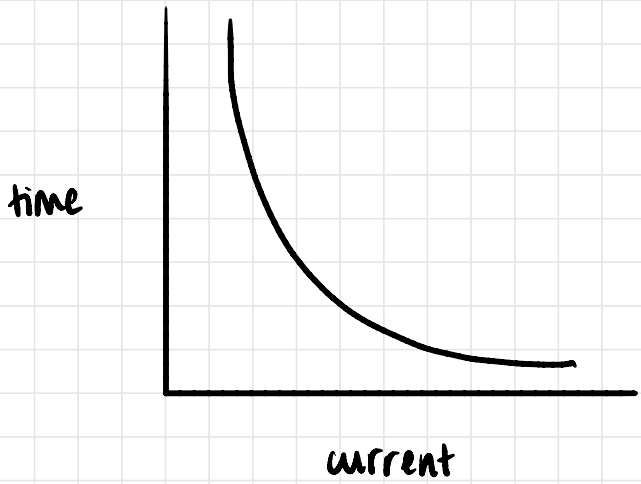
Desirable Properties of Fuse

- low MP (Sn, Pb)
- high conductivity (Cu, Ag)
- highly +ve reduction potential (Ag)
- low cost (Pb, Sn, Cu)

Important Properties

- current rating
- fusing current
- fusing factor = $\frac{\text{fusing current}}{\text{rated current}}$ (> 1)

Fuse Characteristics



DC Fuse and AC Fuse

- DC fuse bulkier than AC fuse
- Reason: formation of arc in DC fuse stronger as current/voltage does not cross 0
- discharge through air
- ∴ distance must be maintained

- can be extinguished using gases
- we do only AC fuses

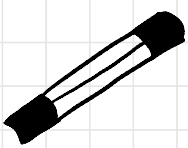
Types of fuses

- AC fuse
  - High voltage
    1. Cartridge type HRC
    2. Liquid type HRC
  - Low voltage
    1. Cartridge type
    2. Rewirable
    3. Drop out
    4. Striker
    5. Switch
- DC fuse

LOW VOLTAGE

Cartridge Fuse

- cylindrical shape
- contact points at each end



Rewirable Fuse

- household; aka KIT-KAT fuse

Drop Out Fuse

- melting causes element to fall under gravity
- used for protection of outdoor transformers

Striker Fuse

- mechanical device used for tripping/indicator circuits
- enough force & displacement

Switch Fuse

- compact combination of switch and fuse
- low and medium voltages
- 3 striker fuse — switch fuse (3ϕ supply)

HIGH VOLTAGE HRC

- High rupturing capacity
- Silica gel and liquid to extinguish arc
  - silica gel → cartridge
  - liquid → liquid

Cartridge Type HV HRC Fuse

- Construction similar to low voltage
- Special design features incorporated

Liquid Type HV HRC Fuse

- Filled with CCl_4 — to extinguish arc
- Wide range of applications
- Employed in transformer protection
- Circuits upto 1600A, 132kV

Advantages & disadvantages - ppt

Q: A fuse wire of circular cross section has radius = 0.8 mm. The wire blows off at a current of 8A. Calculate fusing current if the radius of the wire is 0.2mm

$$R = \frac{\rho l}{A}$$

$$\text{heat power} = I^2R = \frac{I^2 l \rho}{\pi r^2} \propto \text{surface area}$$

$$\frac{I^2 l \rho}{\pi r^2} \propto 2\pi r l$$

$$\frac{I^2}{r^3} = \text{constant}$$

$$\frac{8^2}{0.8^3} = \frac{I_2^2}{0.2^3} \Rightarrow I_2 = 1\,A$$

MCB (upto 100A)

- Minature circuit breaker
- Low voltage; homes
- Instead of fuse
- Automatically switches off circuit during overload/ faulty conditions
- Tripping → knob goes to off position
- Easily identifiable faulty areas
- Usually more expensive

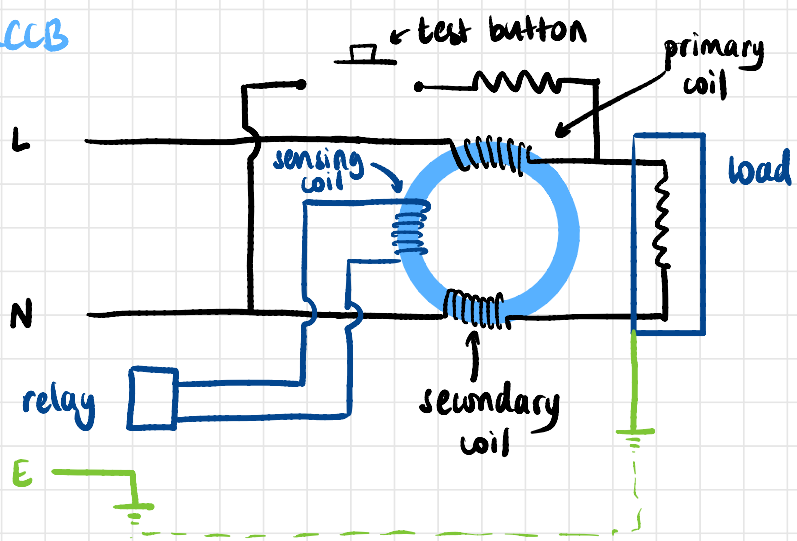
Working

- Due to thermal effect of overcurrent and due to electromagnetic effect of overcurrent
- Bimetallic strip — bends due to heating

ELCB

- Earth leakage circuit breaker
  - ↳ voltage ELCB - ELCB
  - ↳ current ELCB - RCCB
- detects leakage in earthing wire

RCCB



- As long as line current = neutral current, switch closed
- relay controls RCCB
- if there is leakage to earth from load, MMF mismatch and relay opens switch
- test button to test before adding load in industries

MCCB

- Moulded case circuit breaker
- High V, ~1000A
- Works like MCB
- Extra protection for outer casing (hard plastic, ceramic) — arc
- Bimetallic strip

WIRES & CABLES

- Wire - single electrical conductor
- Cable - group of wires swathed in sheathing
- To conduct electricity

Wires

- Domestic, small industries
- Wiring in appliances
- Solid and stranded

Cables

- Small and big industries
- Distribution lines
- Transmission lines

Types of Wires

1. Vulcanised Indian Rubber (VIR) Wire

- VIR used to insulate
- tinned Cu/Al conductor (to prevent sticking to VIR)
- Cotton tape - low moisture conditions
- Bitumen outside

2. Cable Type Sheath (CTS) Wire

- Normal rubber/plastic
- Thick covering - rubber outside
- No moisture protection
- Tinned Cu
- used in landlines
- 250/440 V

3. PVC Wire

- PVC insulating
- Cu/Al
- Widely used
- water, heat, oil, UV
- 600, 660, 1100 V

4. Lead Alloy Sheathed Wires

- Damp places
- Continuous lead sheath covers (moisture)
- Fillers for shape
- 0.12 cm

5. Weather Proof Wires
   - Waterproof coat – extra
   - Same as PVC

6. Mineral Insulated Copper Covered Wire
   - Mines, factories, refineries, furnace
   - Fire protection – hot areas
   - Coating of MgO
   - Cu sheath provided

Cables

- Multiple conductors held together with sheath
- Transmission of power

Construction

conductor → insulation → inner sheath → armour → outer sheath

- conductor → ↓ core
- inner sheath → ↓ moisture protection
- armour (iron / steel) → ↓ used to earth (if leakage)

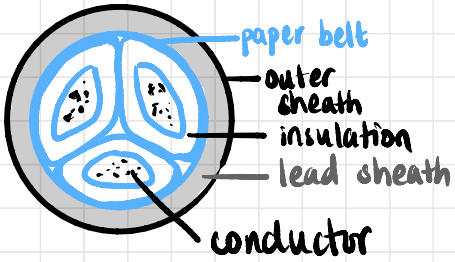
Types of Cables

1. Low tension cables: max 1 kV
2. High tension cables: max 11 kV
3. Super tension cables: max 33 kV
4. Extra high tension cables: max 66 kV
5. Extra super voltage cables: above 132 kV

Classification of Cables Based on Construction

1. Belted Cables

- upto 11 kV
- for 3ϕ
- cores insulated from each other using impregnated paper



2. Pressure Cables

- beyond 66 kV

Oil Filled Cables