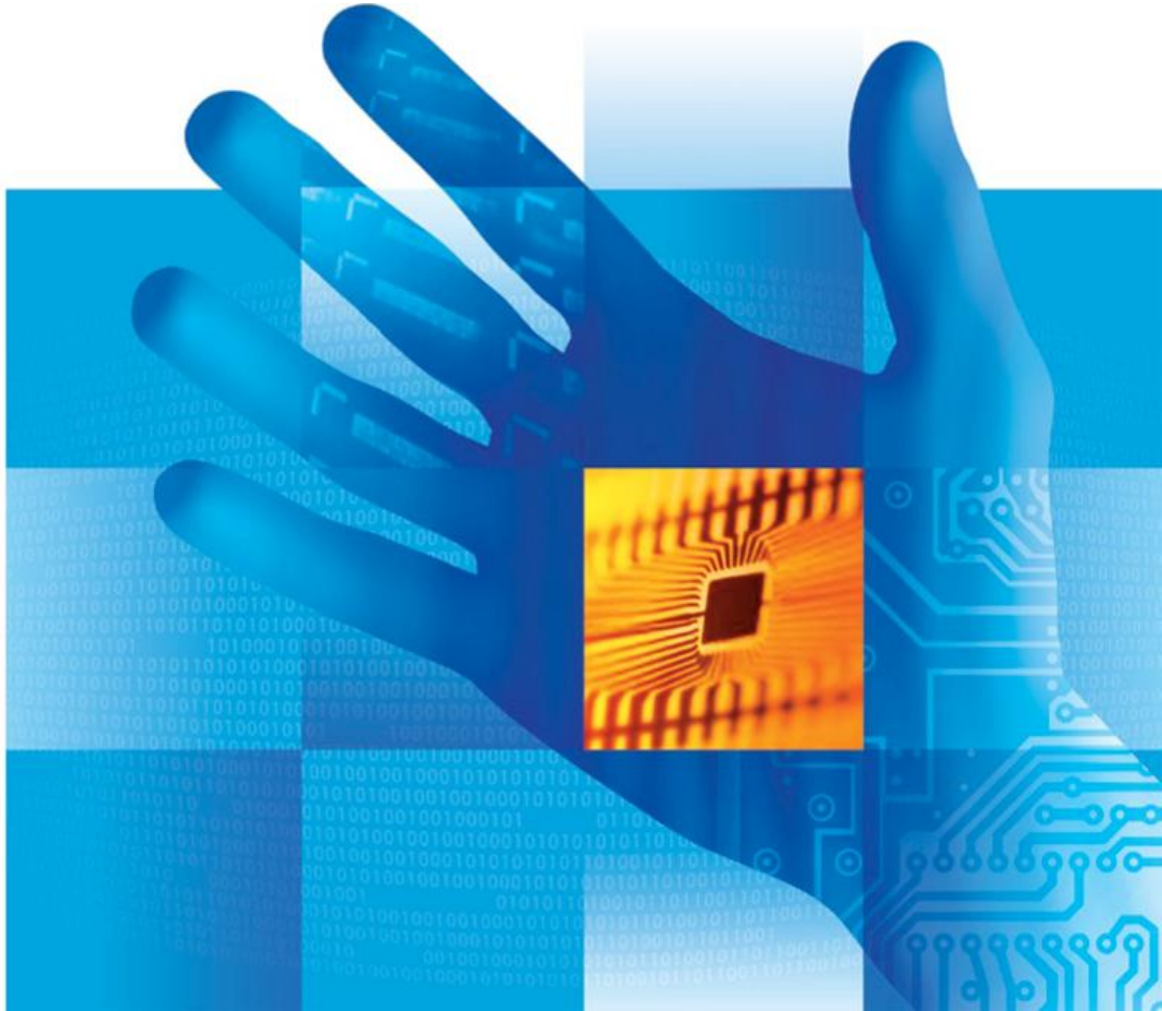
EVROPSKÁ UNIE
Evropské strukturální a investiční fondy
Operační program Výzkum, vývoj a vzdělávání

MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

7. ELECTRICAL APPLIANCES



Doc. Ing. Stanislav Kocman, Ph.D.

7. 2. 2018, Ostrava

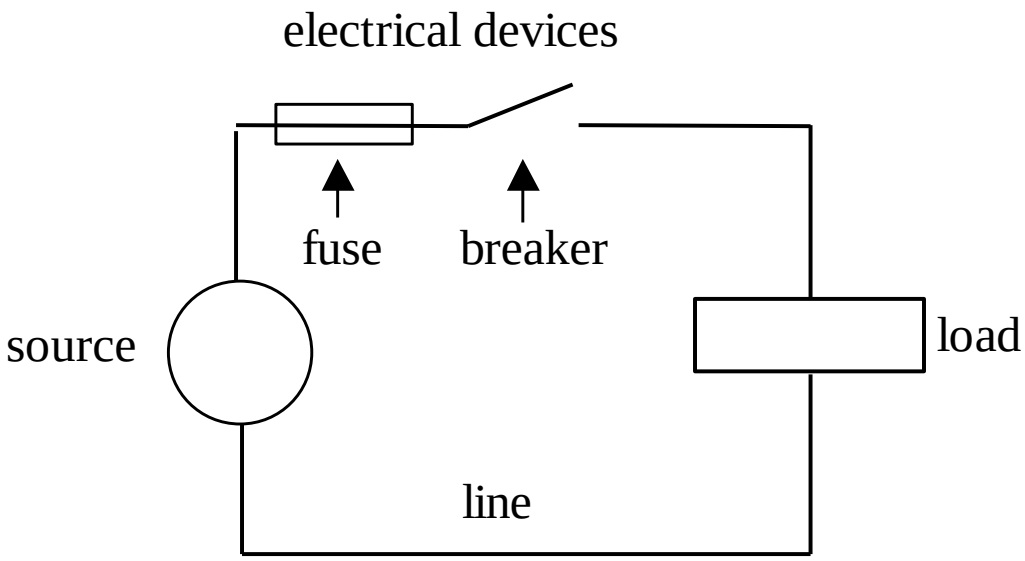
LECTURE PLAN

- division, function, contacts of electrical appliances
- electrical arc and possibilities of its extinction
- switchgears: basic overview, construction and usage of contactor and relay
- protective appliances: fuses and their division and characteristics, principle of circuit breaker
- overvoltage protective devices, earth-leakage breaker: basics and applications

Division and function of electrical appliances

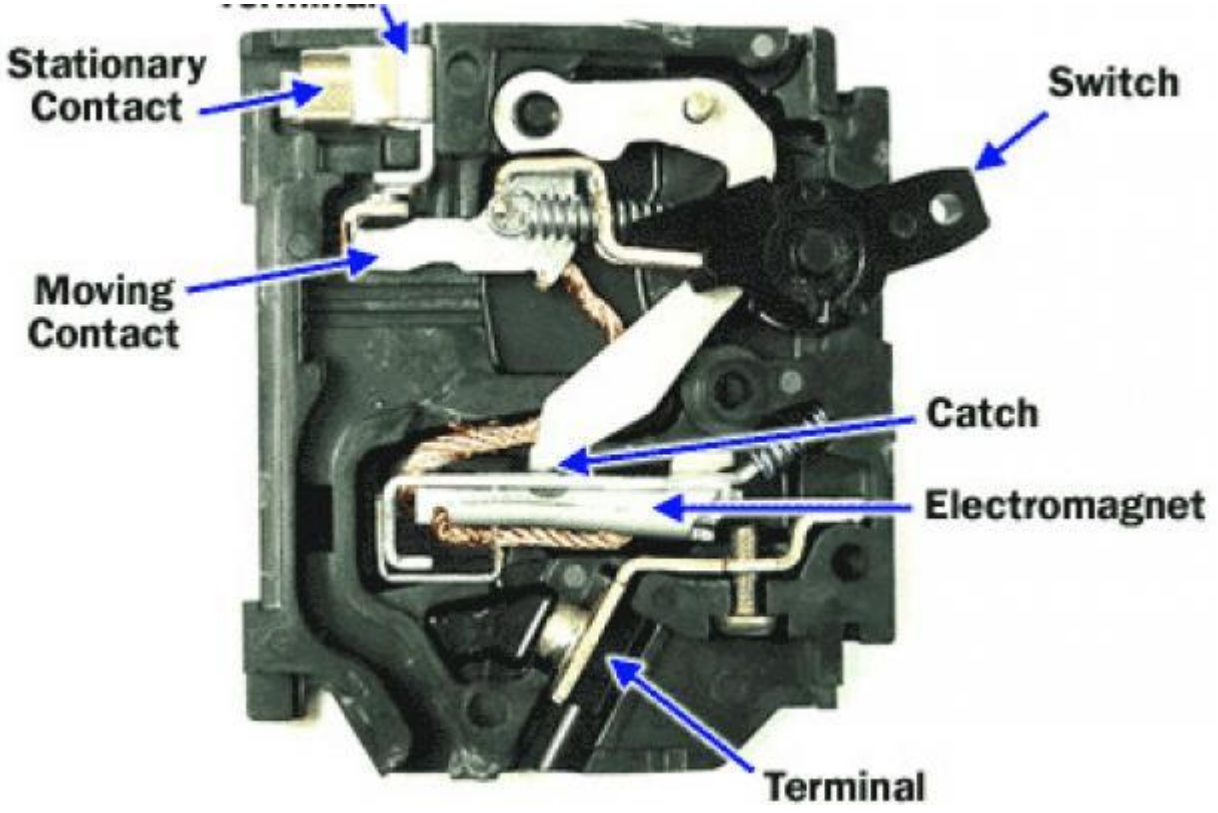
- connecting and disconnecting of no-load electrical circuits
  - disconnecter
- connecting and disconnecting of loaded electrical circuits
  - circuit breaker
  - contactor, relay
  - overcurrent circuit breaker
  - switches
- controlling of electrical circuit or some components
  - controller
  - starter
- protecting of electrical devices and transmission lines
  - overcurrent circuit breaker
  - fuse
  - lightning arrester
- protecting of beings against electrical shock
  - residual-current device (earth-leakage breaker)

Simple electrical circuit



Contacts of electrical appliances





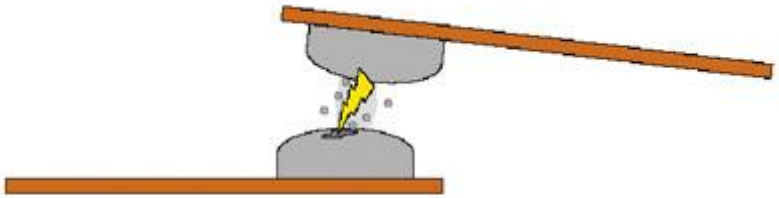
Requirements on contacts

- to carry electrical current very well
- to drain heat from the point of the contact connection away
- to be resisting to a corroding medium
- to resist to an electric arc influences
- to have a high melting degree
- mechanical strength
- to be economical

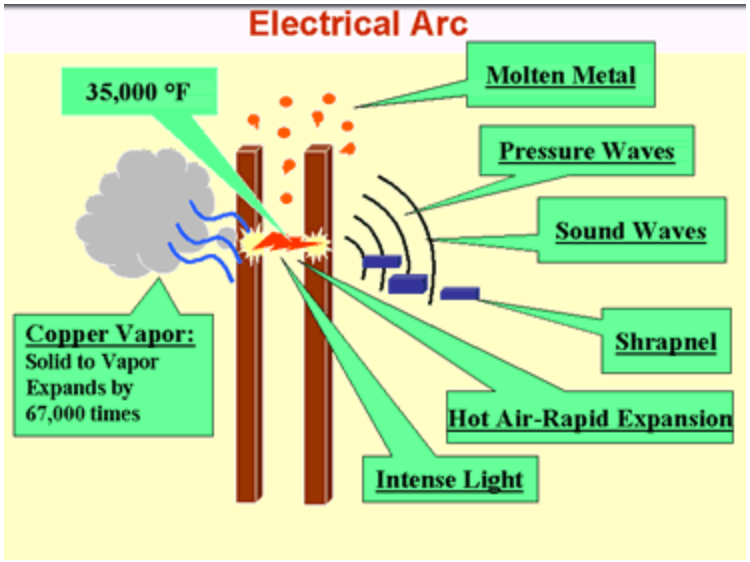
Materials for contacts

- copper, brass, bronze, alloys with silver
- silver, gold, platinum (but only in special applications)
- special metallic mixtures consist of two components (copper, silver) and (tungsten, nickel, graphite, etc…)

Electrical arc



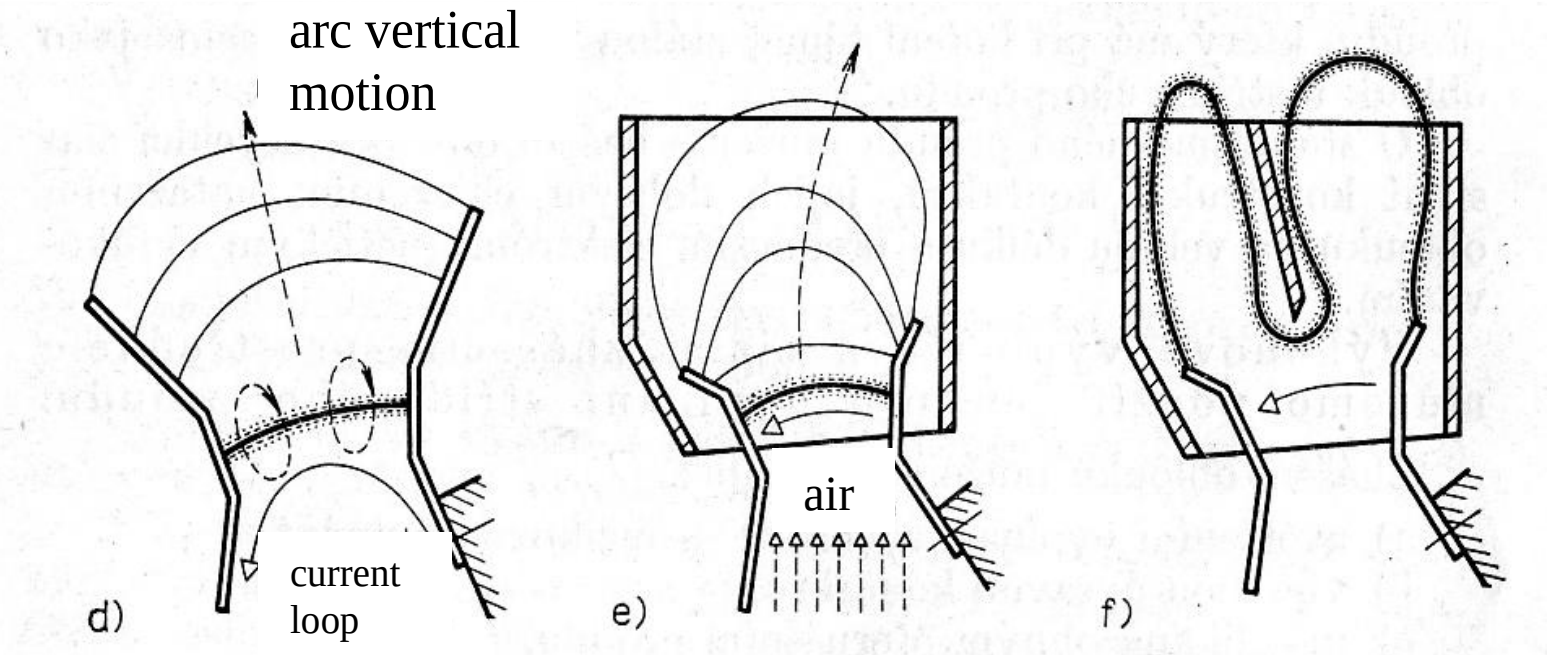
Mainly between disconnecting contacts of a switch under load





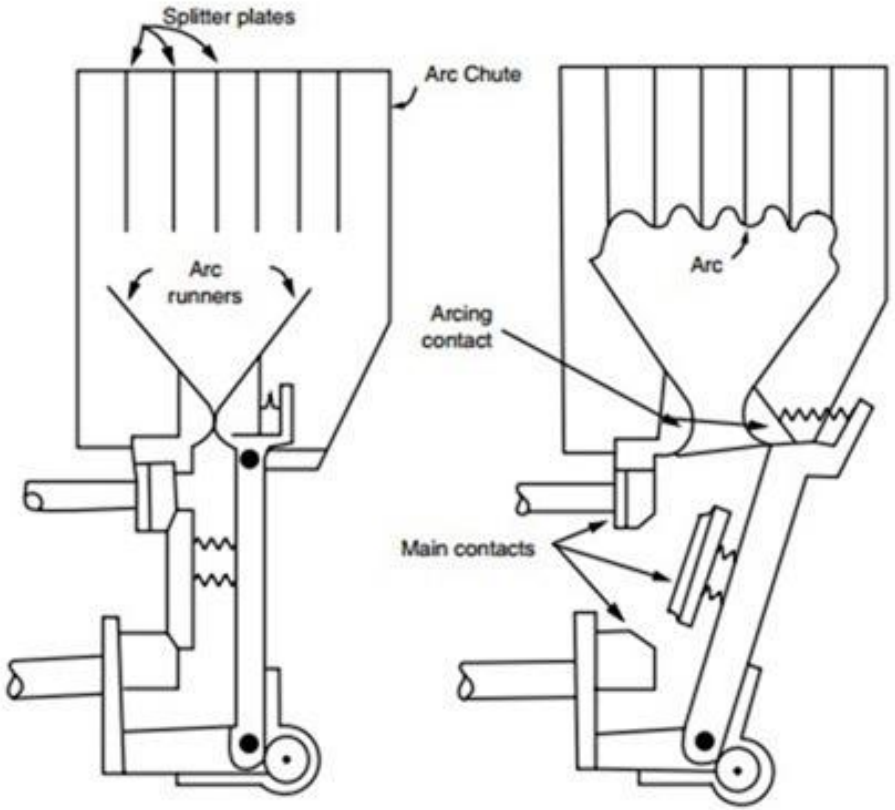
Possibilities of arc extinction

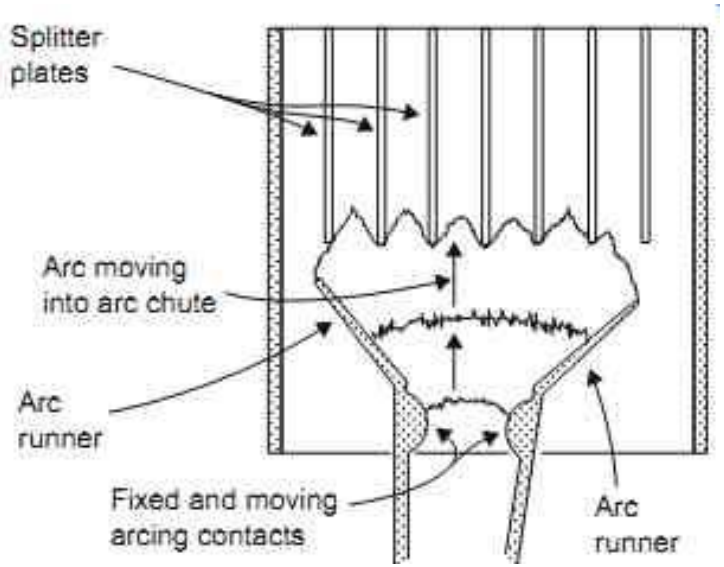
Prolong its length: pneumatic or magnetic blowout



Possibilities of arc extinction

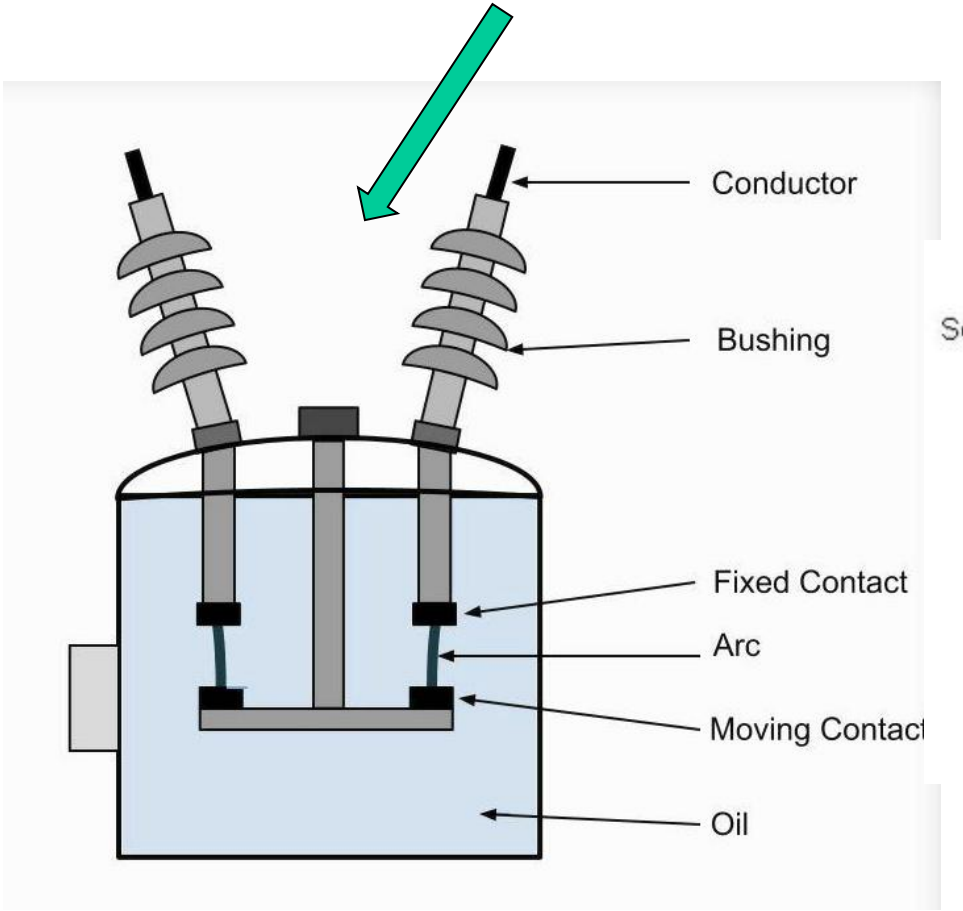
Arc splitting: arc chute

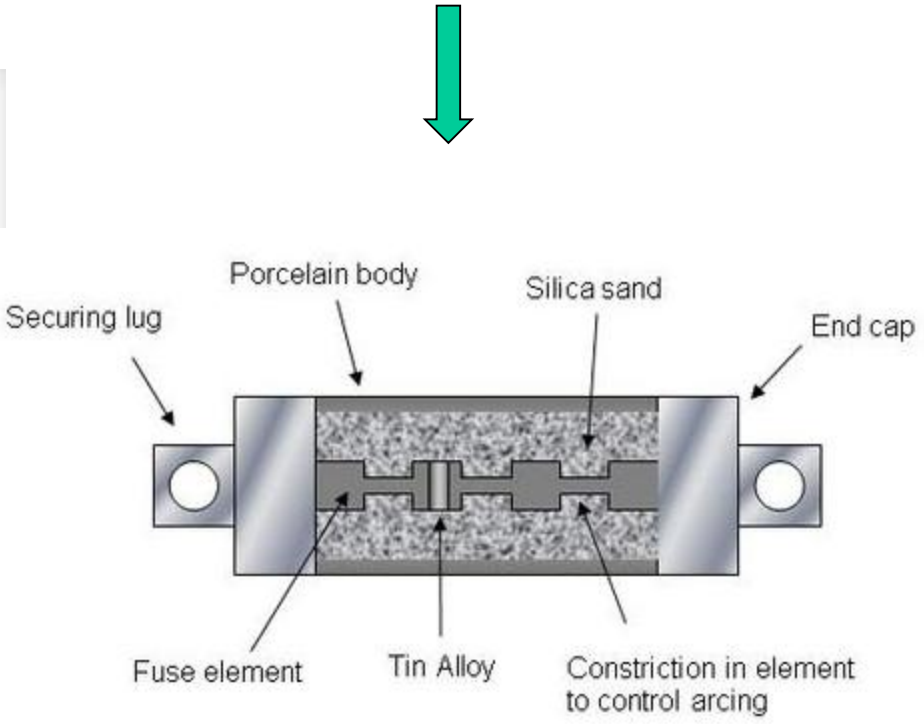




Possibilities of arc extinction

Cooling: immersion in transformer oil, placing in silica sand (fuse)





Switchgears

Basic overview

Manually operated

Automatically operated switches (acting as a sensor)

Electrically operated

Low-voltage

Medium-voltage

High-voltage

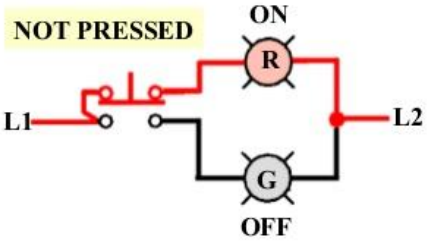
Manually operated

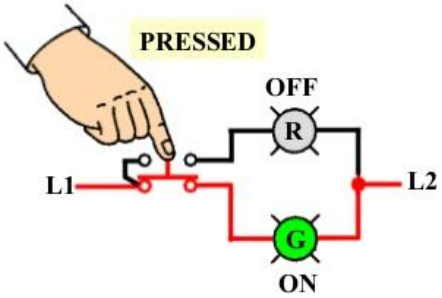
Construction

Manually Operated Switches



The break-make pushbutton is used for interlocking controls. In this switch the top section is NC, while the bottom section is NO. When the button is pressed, the bottom contacts are closed as the top contacts open.





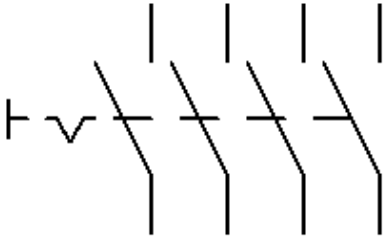






Toggle Switch | Slide Switch | Rocker Switch

Contact symbol



Cam switch



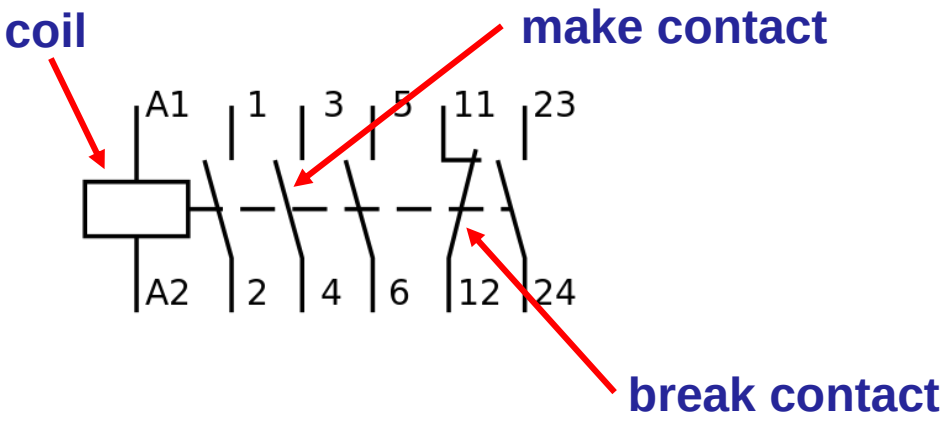
Limit switch



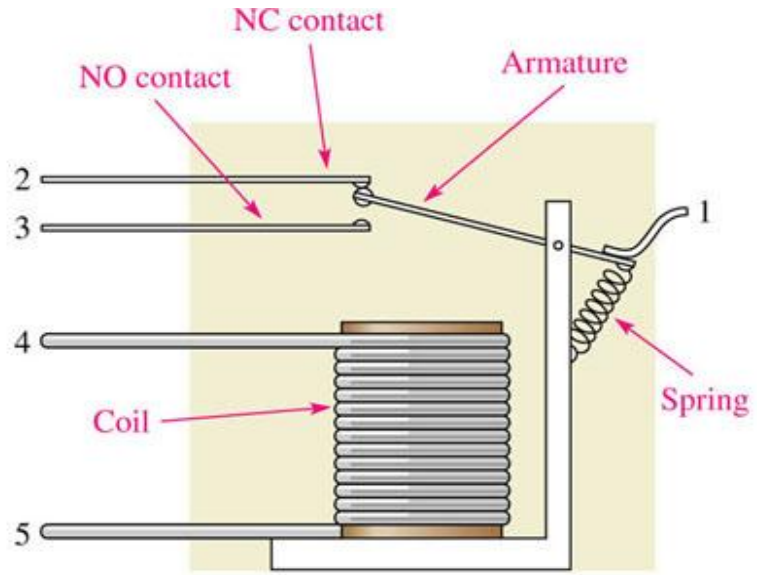
Electrically operated

Relay

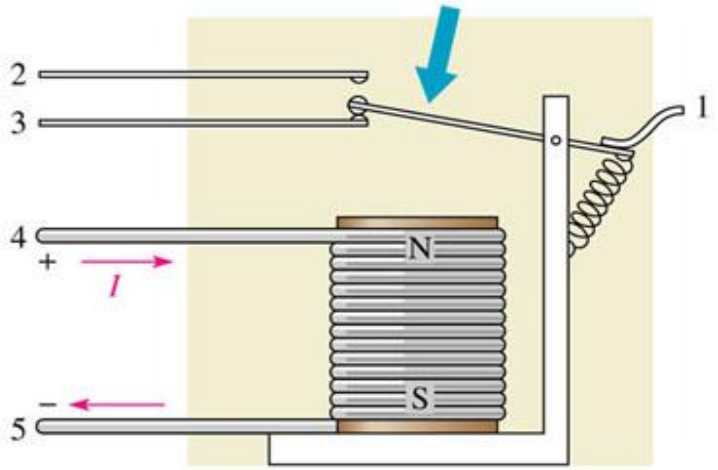
Contact symbols







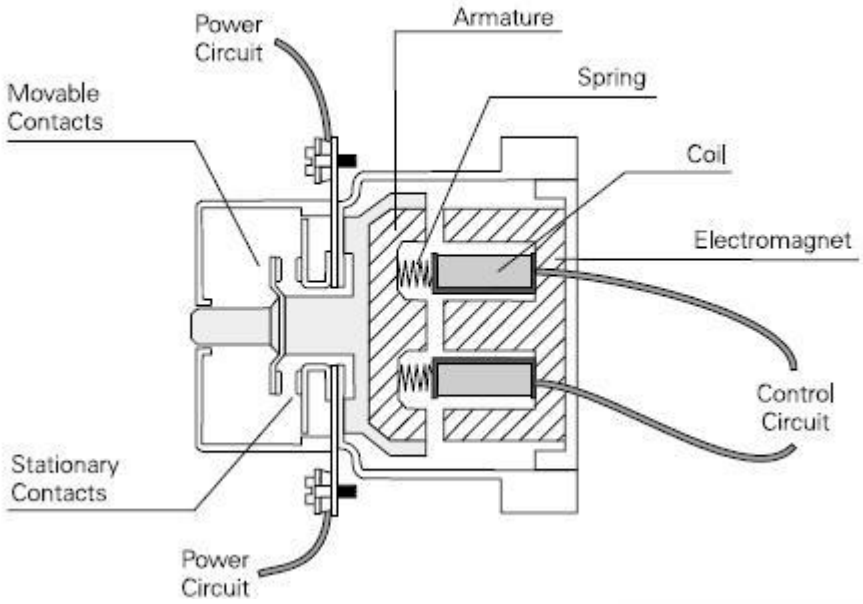
(a) Unenergized: continuity from terminal 1 to terminal 2



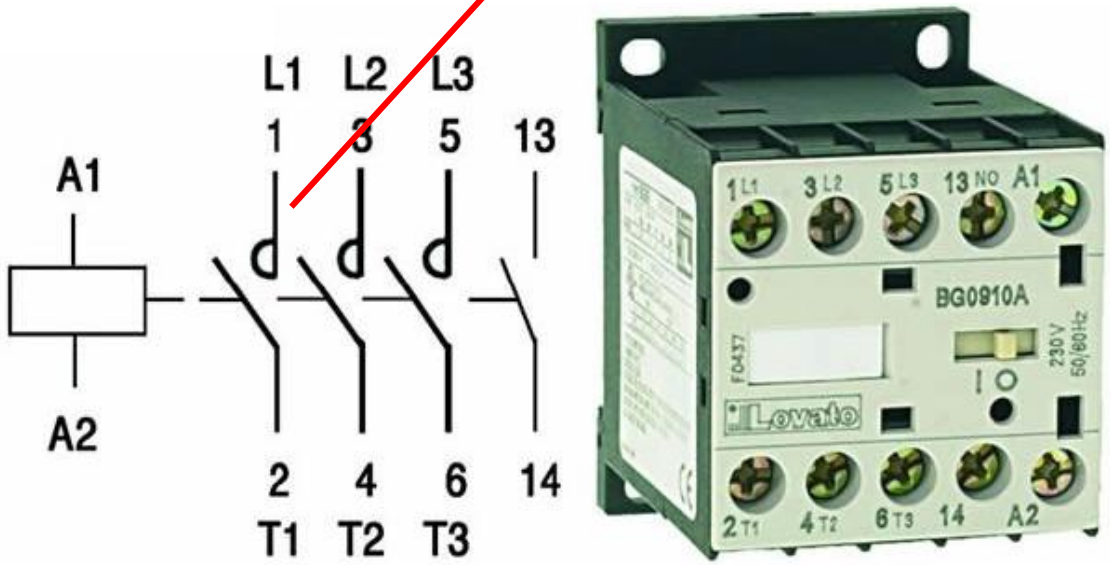
(b) Energized: continuity from terminal 1 to terminal 3

Electrically operated

Contactor

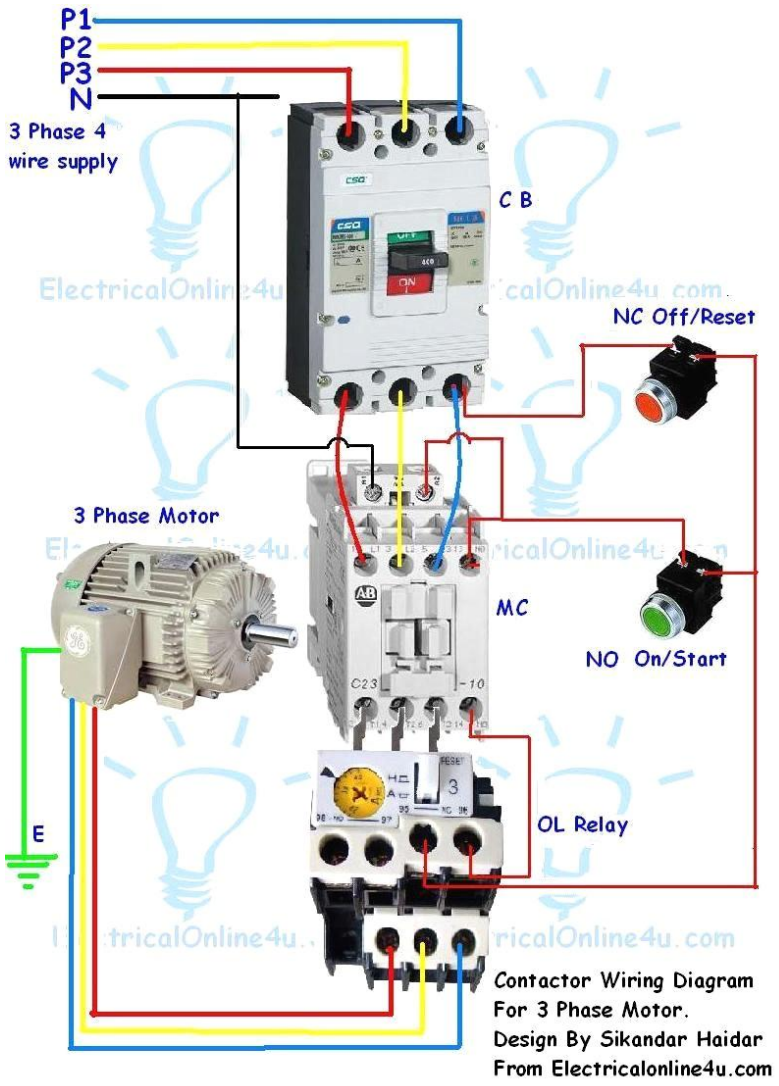


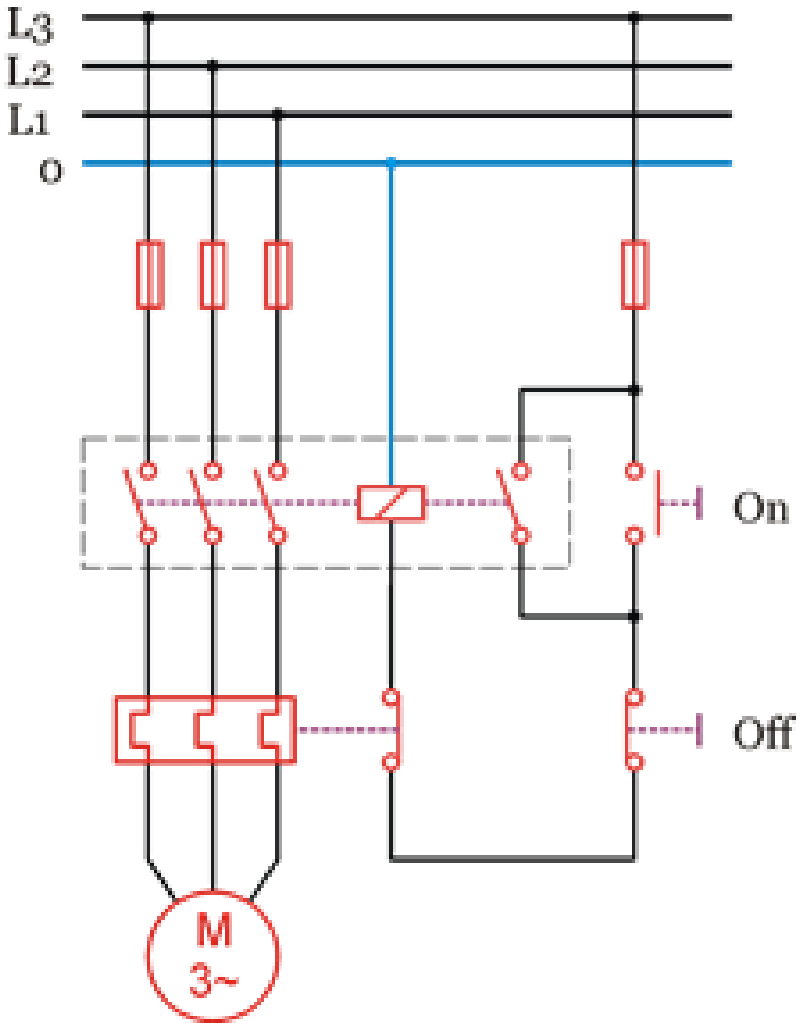
main contact



Electrically operated

Usage of a contactor: example





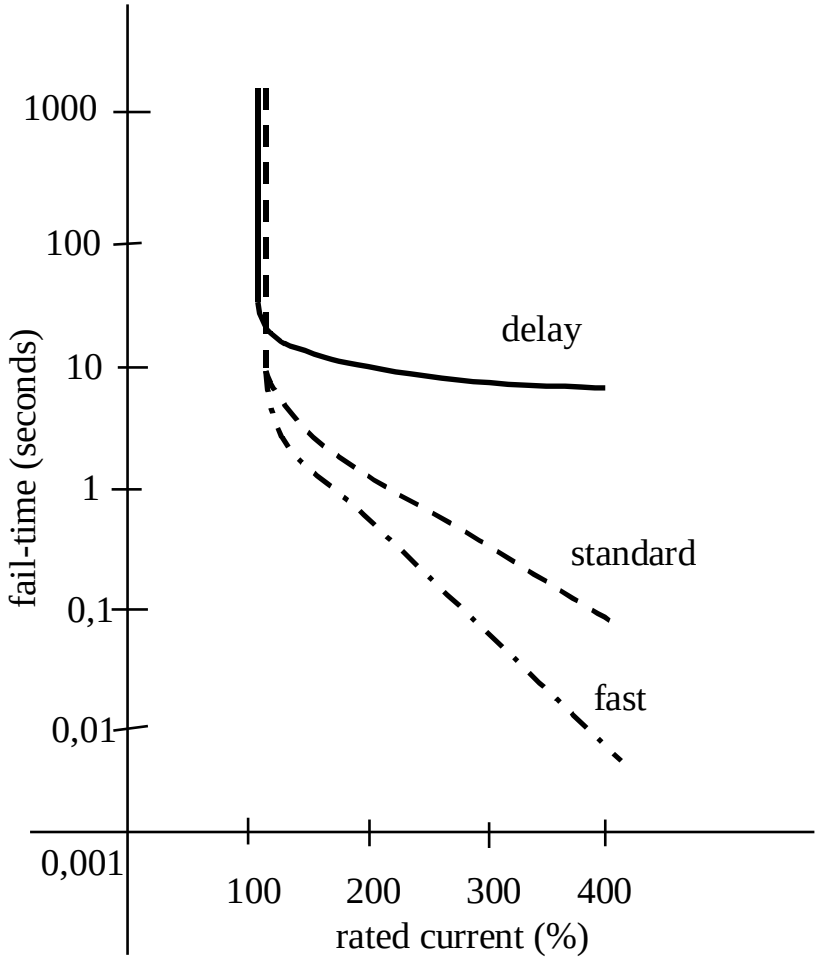
Protection devices

Fuses: their division and characteristics

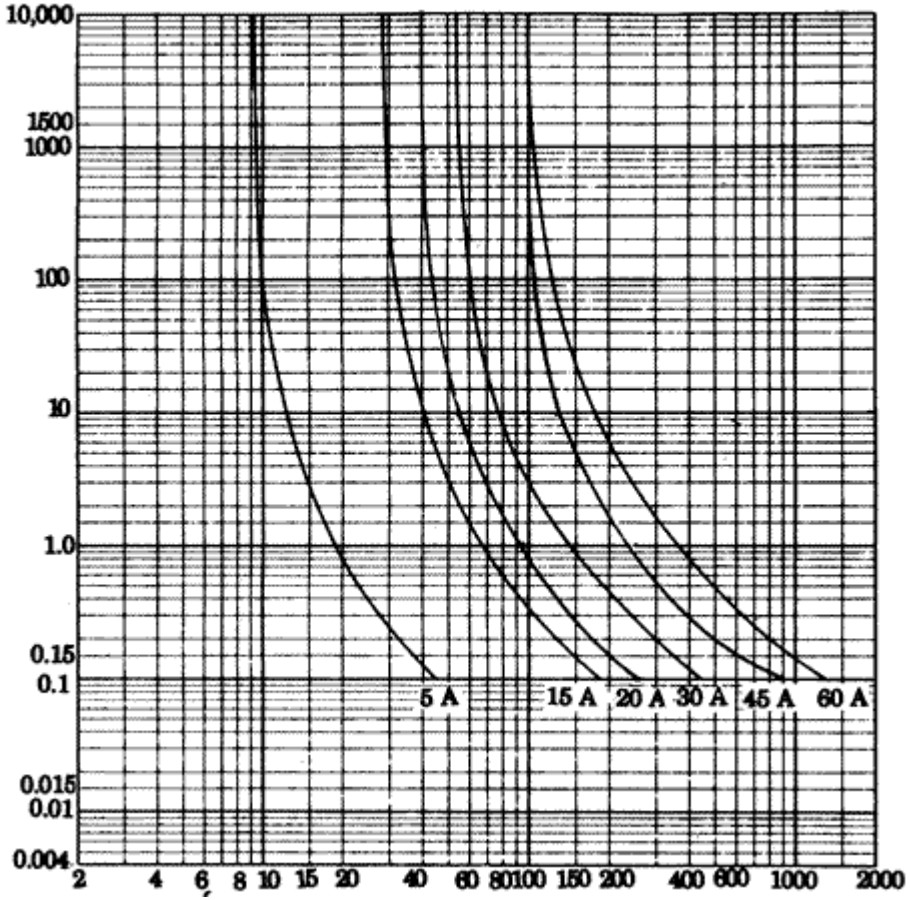
- to provide overcurrent protection of an electrical circuit
- produced in three basic time delay ratings:
  - delay (for induction motors)
  - standard (power line and appliances)
  - fast (semiconductor devices)
- designed as:
  - tube fuse (electronic devices, domestic appliances)
  - screw-in fuse (for power line and appliances)
  - industrial fuse (for power line with high currents)
  - automotive fuse (protect the wiring and electrical equipment for vehicles
- characteristic parameters:
  - rated current and voltage
  - breaking capacity
  - the I^2t value

The time required for fuse to open

division



example



Construction

tube fuse



screw-in fuse



industrial fuse



cylindrical fuse

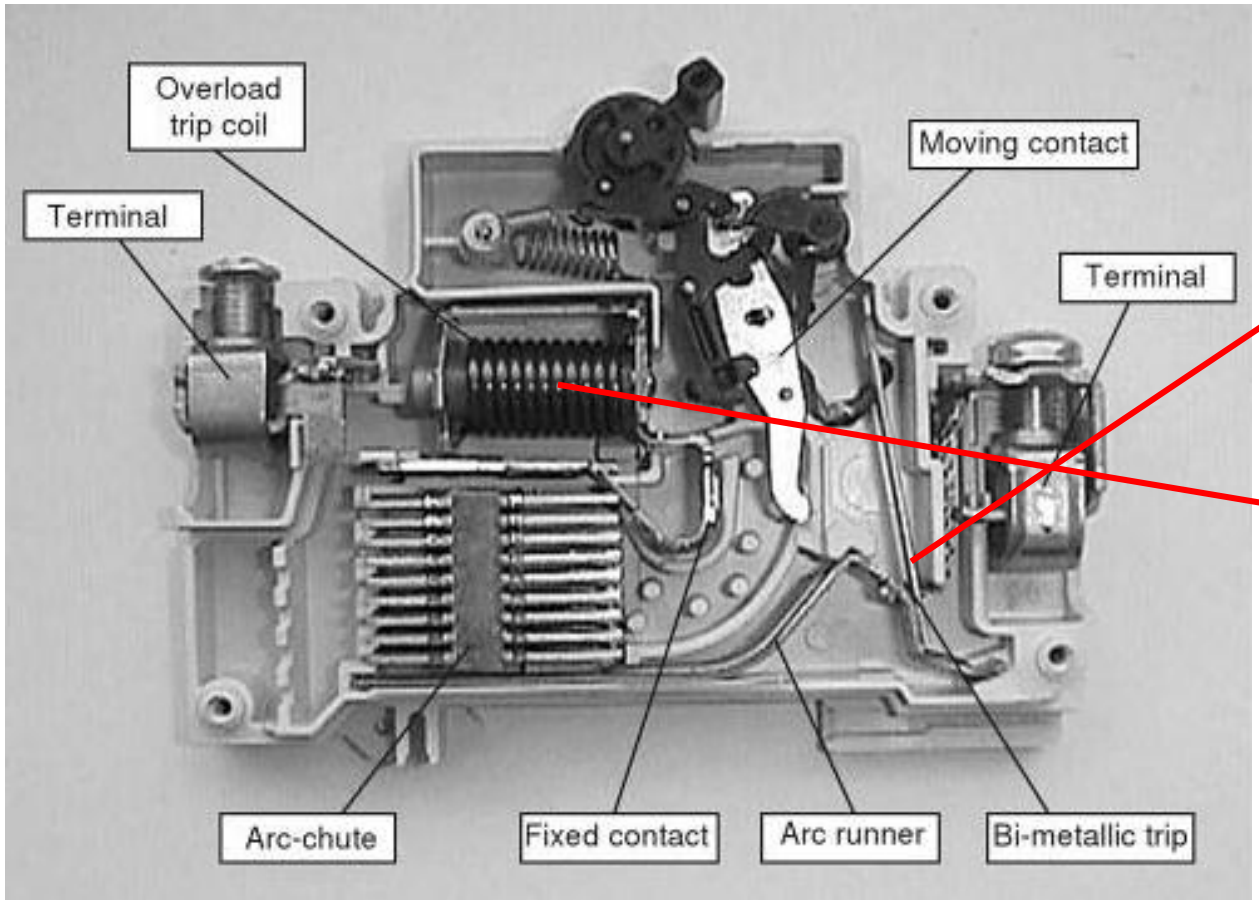


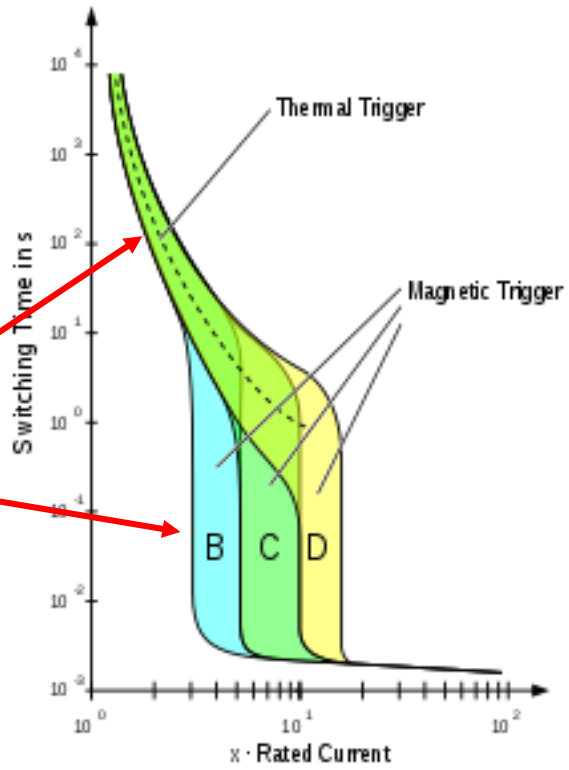
automotive fuse



Protection devices

Principle of circuit breaker





Design of circuit breaker

single-phase



three-phase

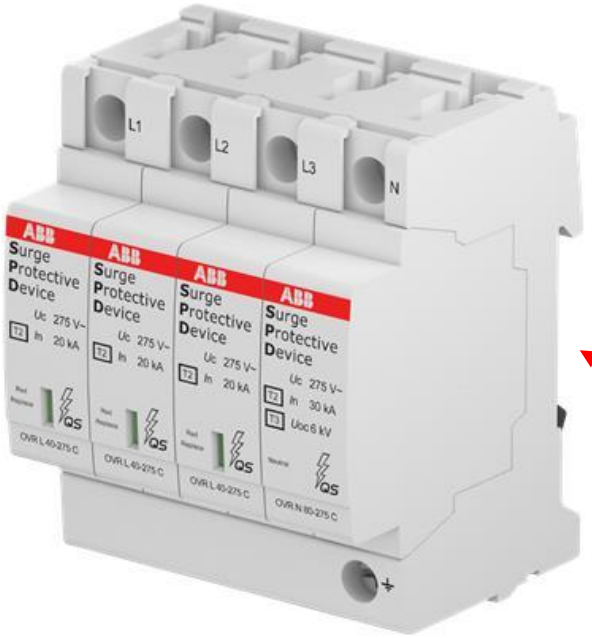


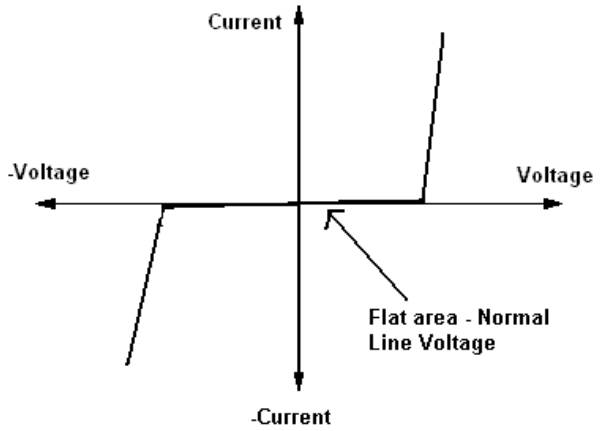
Overvoltage (surge) protection devices

Division and characteristics

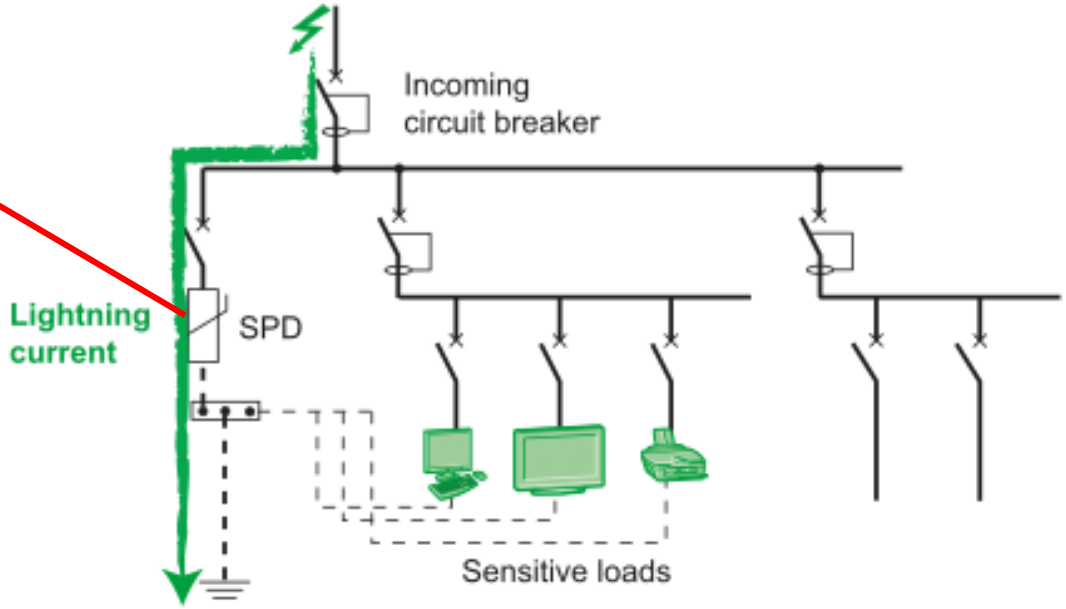
- protecting against electrical surges and spikes, including those caused by lightning
- types:
  - metal oxide varistor (limits voltage)
  - transient voltage suppression diode (a type of Zener diode, limits voltage spikes)
  - gas discharge tube (conducts electric current after becoming ionized by a high voltage spike, shorts voltage to ground)
- characteristic parameters:
  - clamping voltage
  - Joules rating (how much energy a varistor can theoretically absorb in a single event without failure)
  - response time

Operation





Varistor Volt-Ampere Characteristics Curve

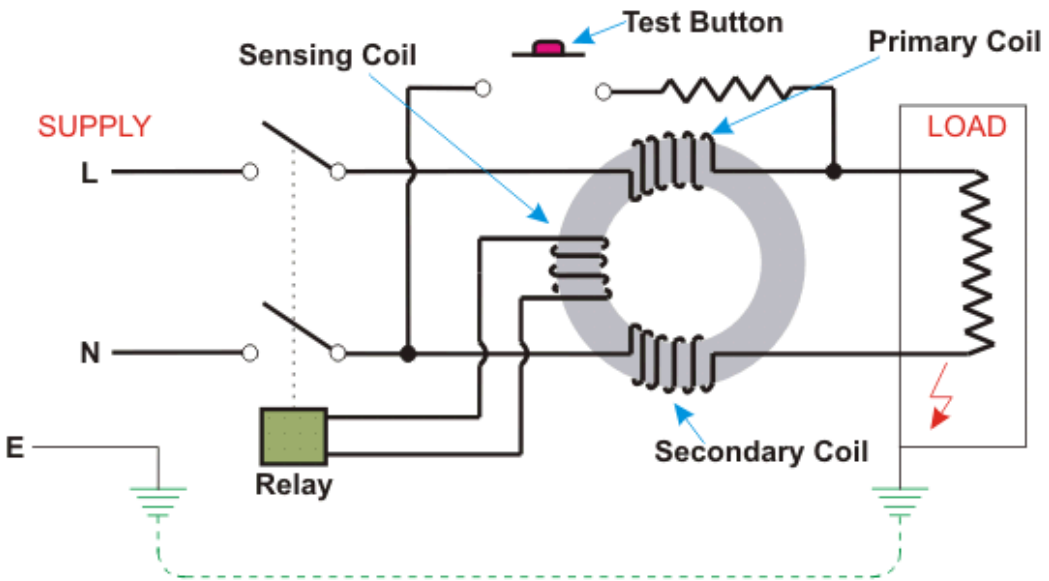


Residual-current device (Earth-leakage breaker)

Division and characteristics

- a safety device used in electrical installations to prevent electric shock
- types:
  - current operated (single or three-phase)
- design:
  - three-winding transformer (single-phase type)
  - relay
  - test button
- characteristic parameters:
  - rated residual operating current
    - e.g. high sensitivity (HS): 5** – 10 – 30 mA (for direct-contact / life injury protection)
  - break time (response speed)
    - e.g. instantaneous (general use): it must trip within 200 milliseconds for rated current

Operation





Working Principle of Residual Current Circuit Breaker

