Distribution Protection -

System components:

34.5kV
41.6kV
69kV or 115kV
13.8kV
downstream
12.47KV

Recloser

(Fuse or Circuit Breaker)

Sectionalizers

Fuse

Customer 1

Customer 2

Fed from another source

Note that distribution systems are always radially connected!

Recloser - combined relay/CT/circuit breaker. Usually attempts 2-4 recloses following a fault.

Sectionalizer - switch that automatically disconnects after set number of fault/trip events. Set to disconnect after one less than max reclose attempts. Ex: 4 reclose attempts → lockout sectionalizer after 3 fault surges.

Fuses: See p. 186 of text

Must coordinate fuse sizes and time characteristics so downstream fuse clears before upstream fuse melts.

Note: Due to line impedance, fault at "a" draws less current than fault on b. (Further "out" on system, lower I_FAULT)
One-line Symbols:

- Control_TERMINATION CABINET (used for plan view drawings)
- CIRCUIT BREAKER (High Voltage)
- AIR-BREAK CIRCUIT BREAKER (Low Voltage)
- FUSED DISCONNECT SWITCH
- FUSED CUTOUT
- DISCONNECT SWITCH
- AIR-BREAK SWITCH w/arc restriction
- CIRCUIT SWITCHER

Vacuum interrupter trips first, then switch opens. Can't interrupt high fault currents like CBs but cheaper. Often used on HV side of transformer. Can close & open on full load current also, so provides function of load-break switch as well.
General goal: closest device upstream from fault must clear.
- Minimize portion of system that goes black. (Zero if possible).

Ex: Permanent Fault at a.

Recloser - 2 fast, 1 slow
Sectonlizer #2 set for lockout
First reclose at 2.
2nd reclose fast
3rd reclose success!

Set sectonlizer at about 0.8 of min fault current it would ever “see” downstream.

About 80% of the time, the first fast reclose restores the system, i.e. fault was temporary - squirrel, bird, wind knocking wires together, trees.

About 10% of the time, the 2nd reclose will succeed, assuming the first did not.

The “fast trips” occur fast enough to prevent melting of downstream fuses. The delayed trip allows fault to persist long enough to clear fuse.
Recloser can also lock out, if downstream coordination is botched or if fault is "close in", i.e. if 50/51 relay is used in recloser, 51 trip would allow reclose sequence but 50 (instantaneous) trip would not.

Various reclose strategies are used. Each utility has their preferences. Most common:

1. Fast (1) ½ sec
2. Slower (several seconds) 2 seconds
3. Long delay (5-10 seconds)

After successful reclose sequence, the recloser will "reset" itself after a certain time. The sectionalizer's counter will also reset, provided it was not driven to lockout.

Note: Reclosers are bad in case of human contact. Utilities always disable reclose if line crew is doing live line work! Human contact or downed lines are bad.