

Unit - IV

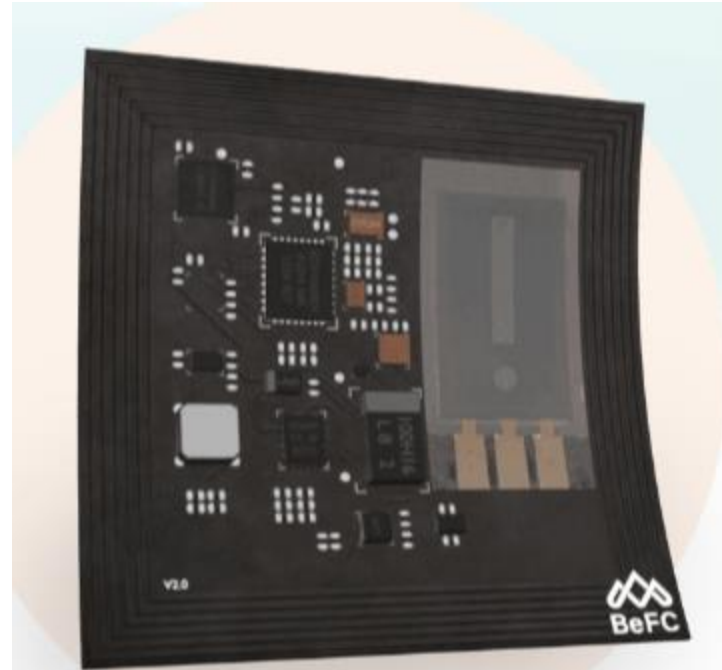
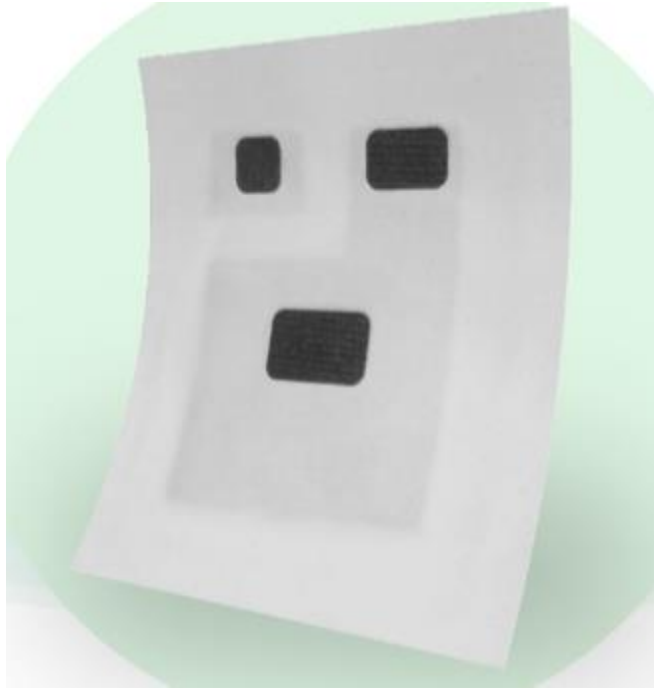
4.3 Electrical Wiring and Safety

Dr.Santhosh.T.K.

Ultrasonic lens cleaning – CES #1



BeFC's paper batteries – CES #2





BMW Color Changing Car



Syllabus

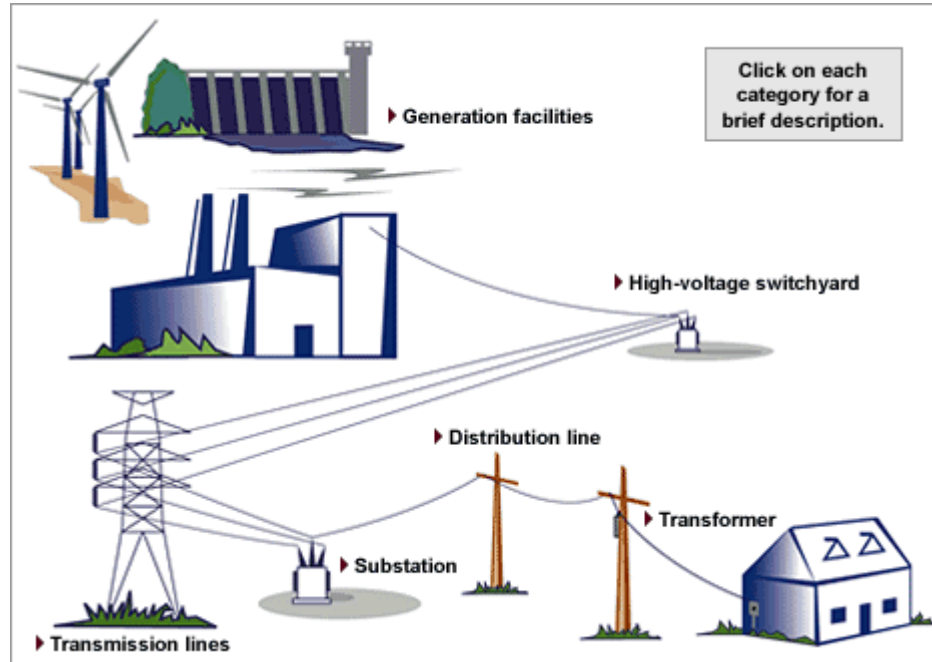
UNIT – IV

11 Periods

Measurements and Sensors: Introduction to measuring devices /sensors and transducers related to electrical signals - Elementary methods for the measurement of electrical quantities, impedance, power and energy in DC and AC systems and their practical application.

Electrical Wiring and Safety: Basic layout of distribution system - Types of Wiring System & Wiring Accessories –Electrical Safety - Necessity of earthing - Types of earthing.

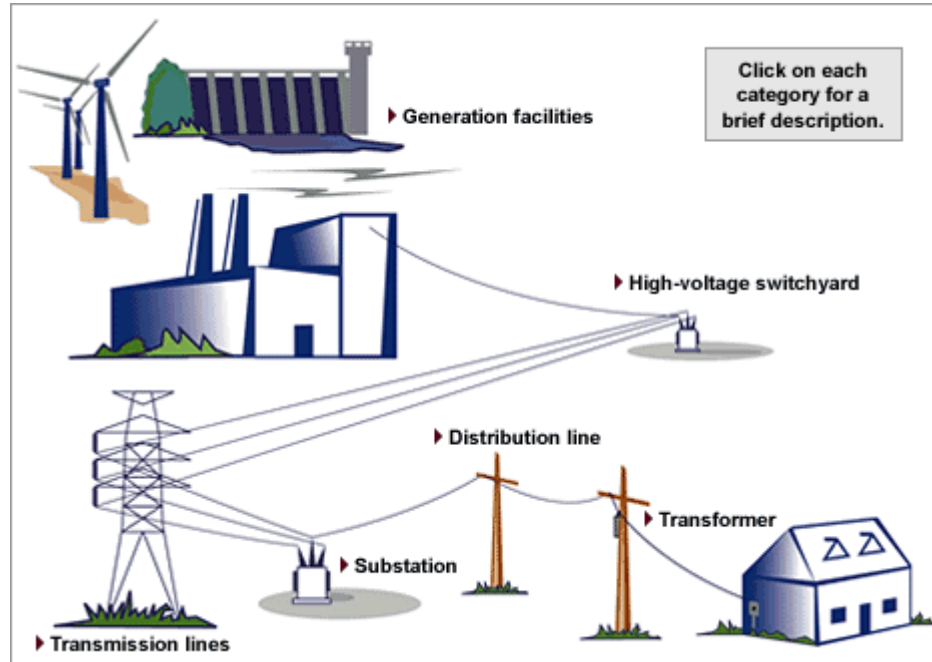
Layout of Distribution System



Generation facilities-

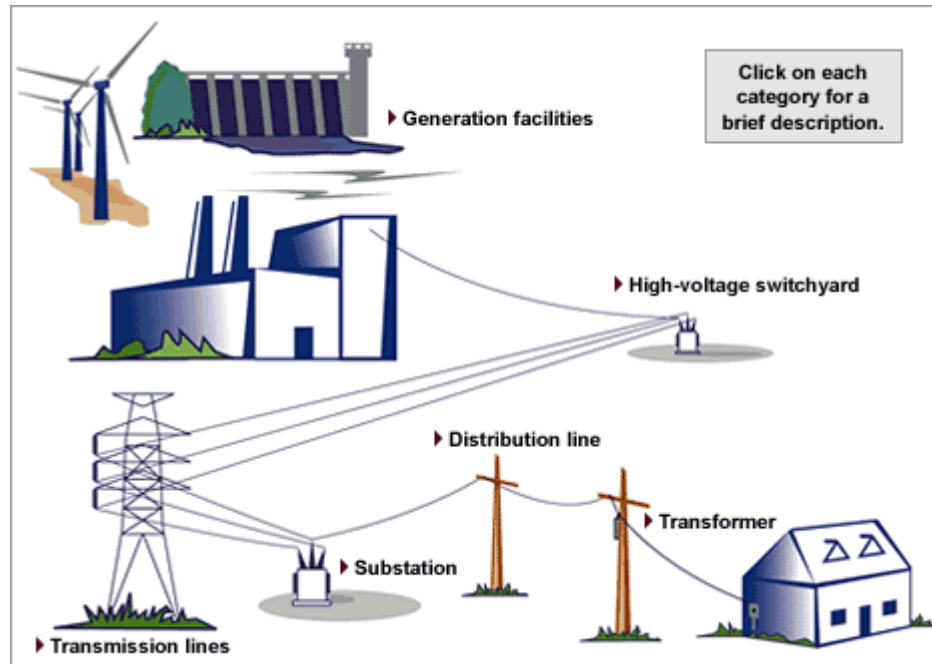
Most electricity is made by turbine blades rotating at speeds high enough to produce electricity in a generator. The blades can be turned by water, steam or wind.

Switchyard



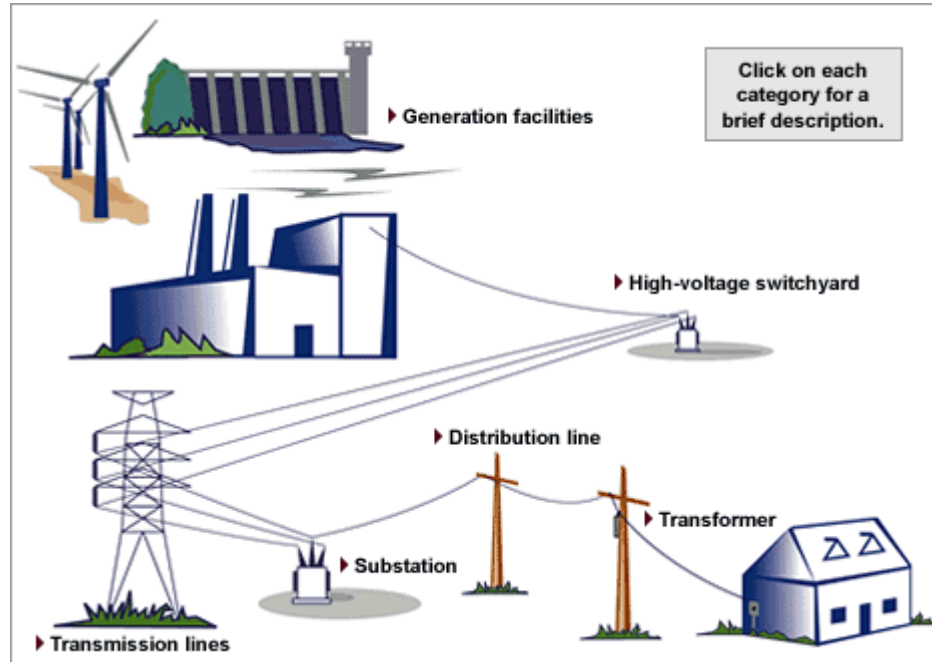
- ▣ High-voltage switchyard- The electricity flows through metal conduction to a switchyard, where a transformer steps up voltage for transmission.

Transmission Lines



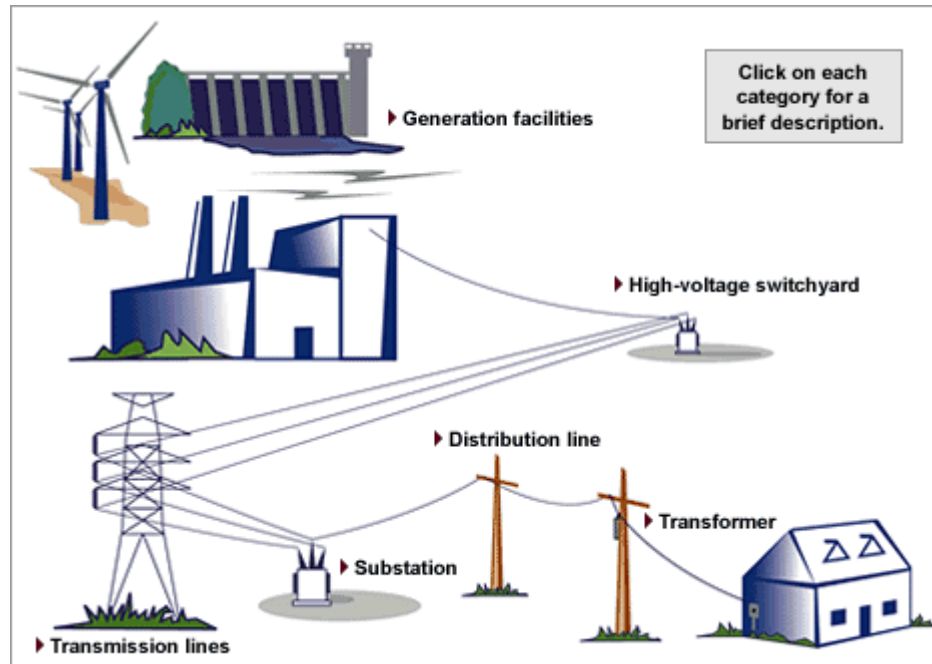
- ▣ Transmission lines -Transmission lines can efficiently carry high-voltage electricity over long distance to substations.

Substations



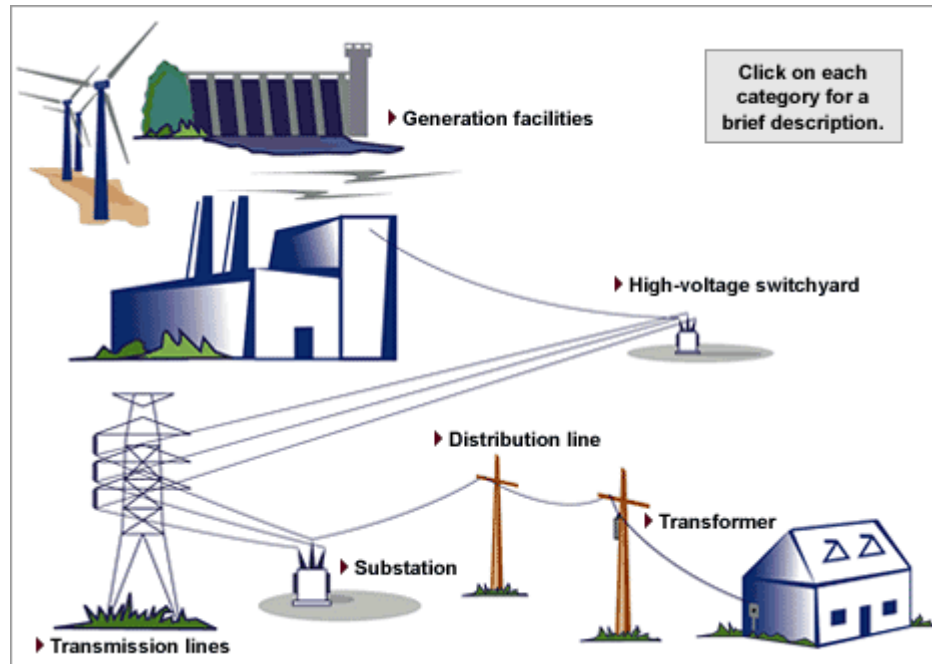
- ▣ Substations -At substations, electricity is stepped down so it can travel over smaller distribution lines to homes and businesses.

Distribution Lines



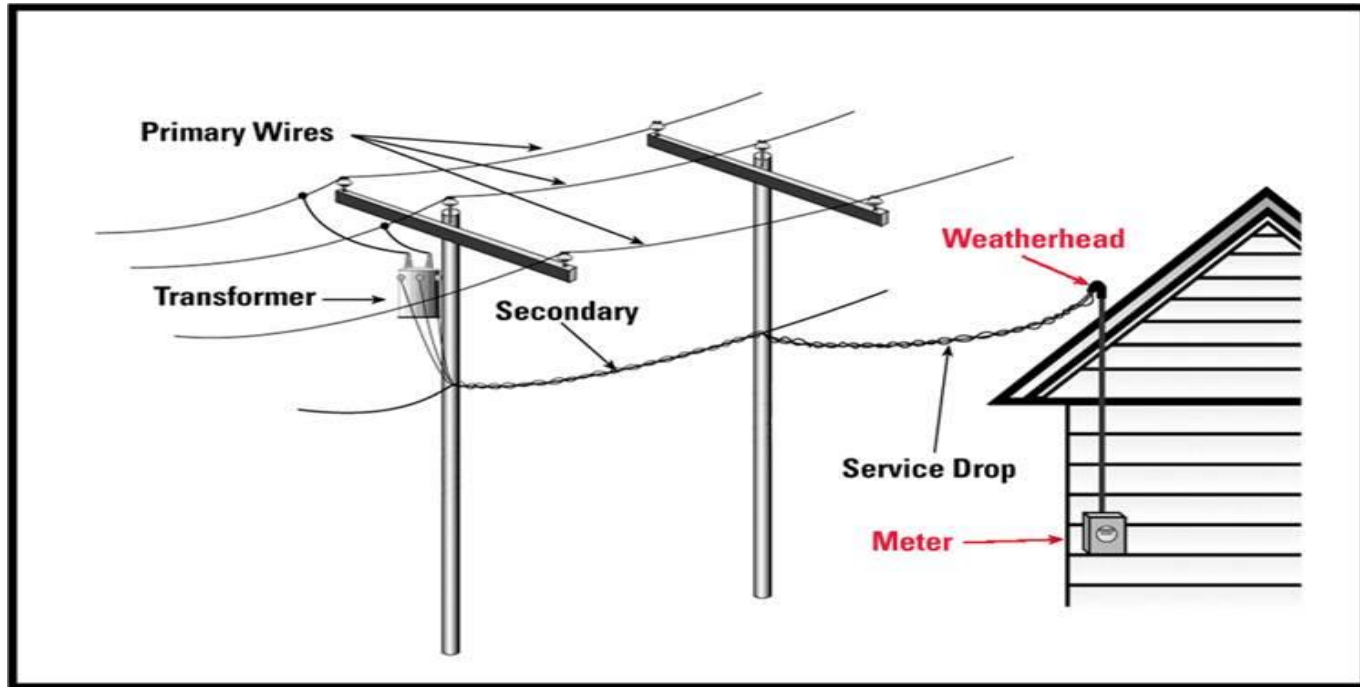
- Distribution lines -Distribution lines carry electricity to neighborhoods.

Transformer



- ▣ Transformer -an electric-pole transformer reduces the voltage to a level that can be used in homes

Service Drop and Meter

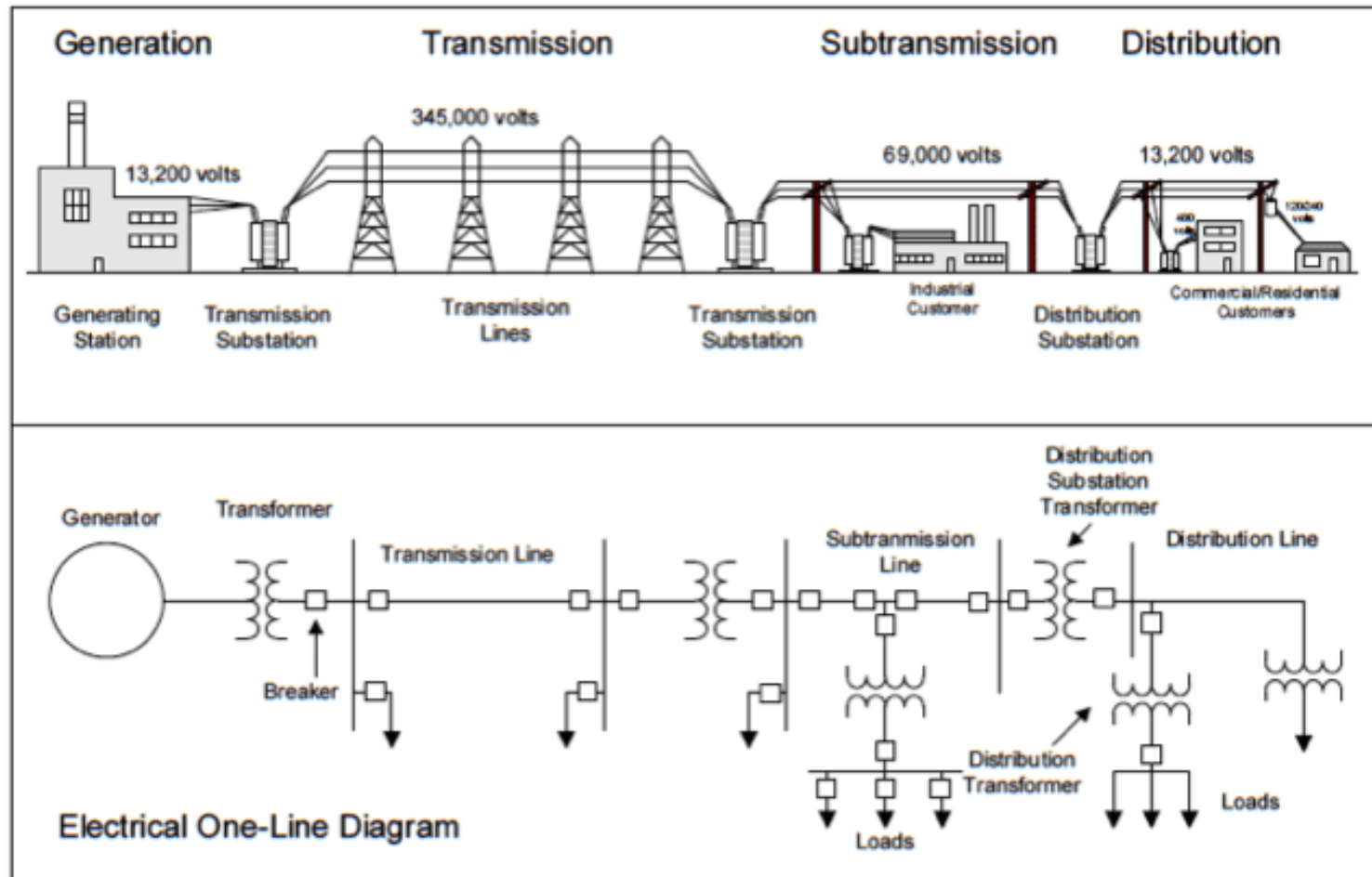


- ▣ The line that connects from the overhead street power lines to your house is called the Service Drop.
- ▣ The utility company owns and is responsible for the Service drop and any wires before they enter the Weatherhead.

Service Panel

- After the wires enter the weatherhead they travel down the large conduit to the Service panel.
- From the panel, the power is distributed to the different circuits throughout the house.

One-line Diagram of an Electric Power System



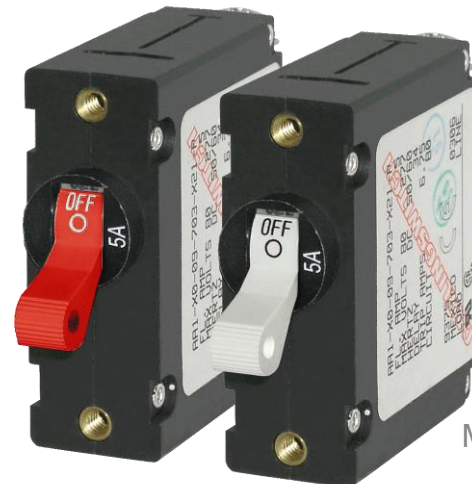
Circuit breaker

- A **circuit breaker** is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by overload or short circuit.
- Its basic function is to detect a fault condition and, by interrupting continuity, to immediately discontinue electrical flow.
- Unlike a fuse, which operates once and then has to be replaced, a circuit breaker can be reset (either manually or automatically) to resume normal operation.



Fuses and Circuit Breakers

- Used to protect wiring from over current
 - In positive or hot wire
- Newer boats use circuit breakers
 - Initially more expensive
- Replace blown fuse with correct rating
- Circuit Breakers should be Marine Grade
 - Trip free
 - Manual reset



BASIS	FUSE	CIRCUIT BREAKER
Working Principle	Fuse works on the electrical and thermal properties of the conducting materials.	Circuit breaker works on the Electromagnetism and switching principle.
Reusability	Fuses can be used only once.	Circuit breakers can be used a number of times.
Status indication	It does not give any indication.	It gives an indication of the status
Switching Action	Fuse cannot be used as as an ON/OFF switch.	The Circuit breaker is used as an ON/OFF switches.
Characteristic Curve	The Characteristic curve shifts because of the ageing effect.	The characteristic curve does not shift.
Protection	The Fuse provides protection against only power overloads	Circuit breaker provides protection against power overloads and short circuits.
Function	It provides both detection and interruption process.	Circuit breaker performs only interruption. Faults are detected by relay system.

Main components in residential application

- Lights and Switches
- Receptacles/outlets
- Hardwired appliances

Types of Wiring

What is Electrical Wiring?

Electrical Wiring is a process of connecting cables and wires to the related devices such as fuse, switches, sockets, lights, fans etc to the main distribution board is a specific structure to the utility pole for continues power supply.

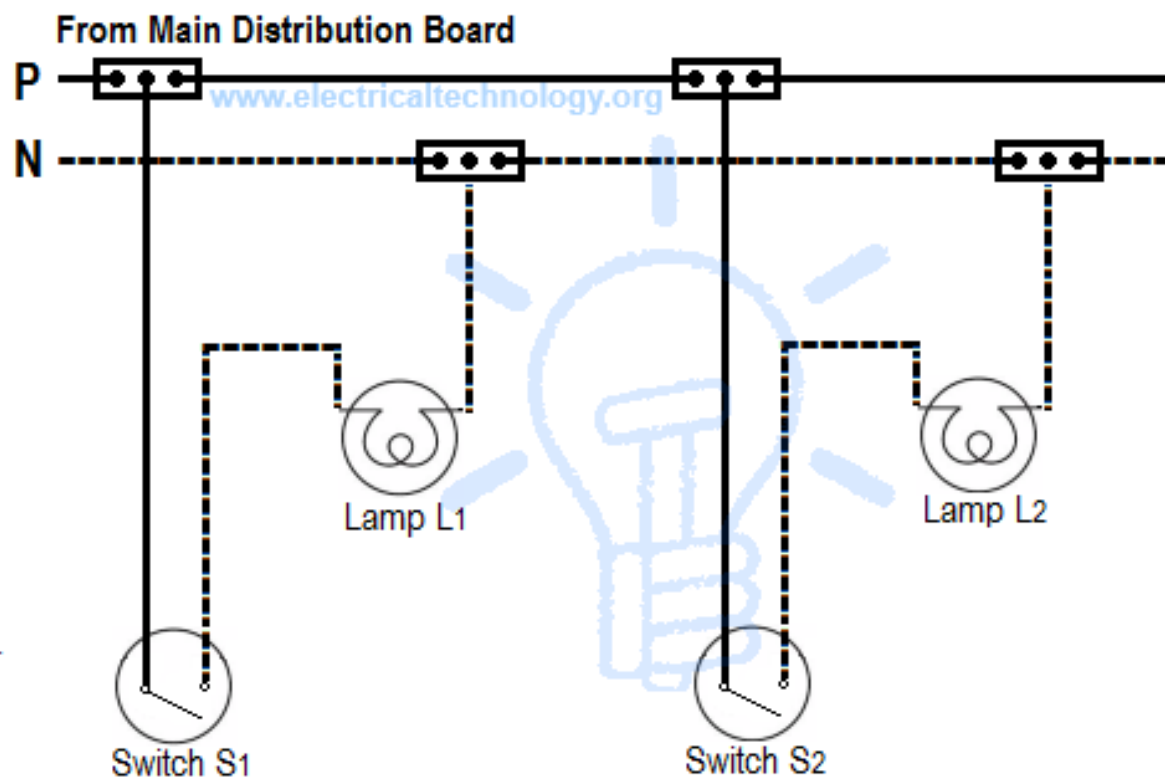
Types

Based on connection

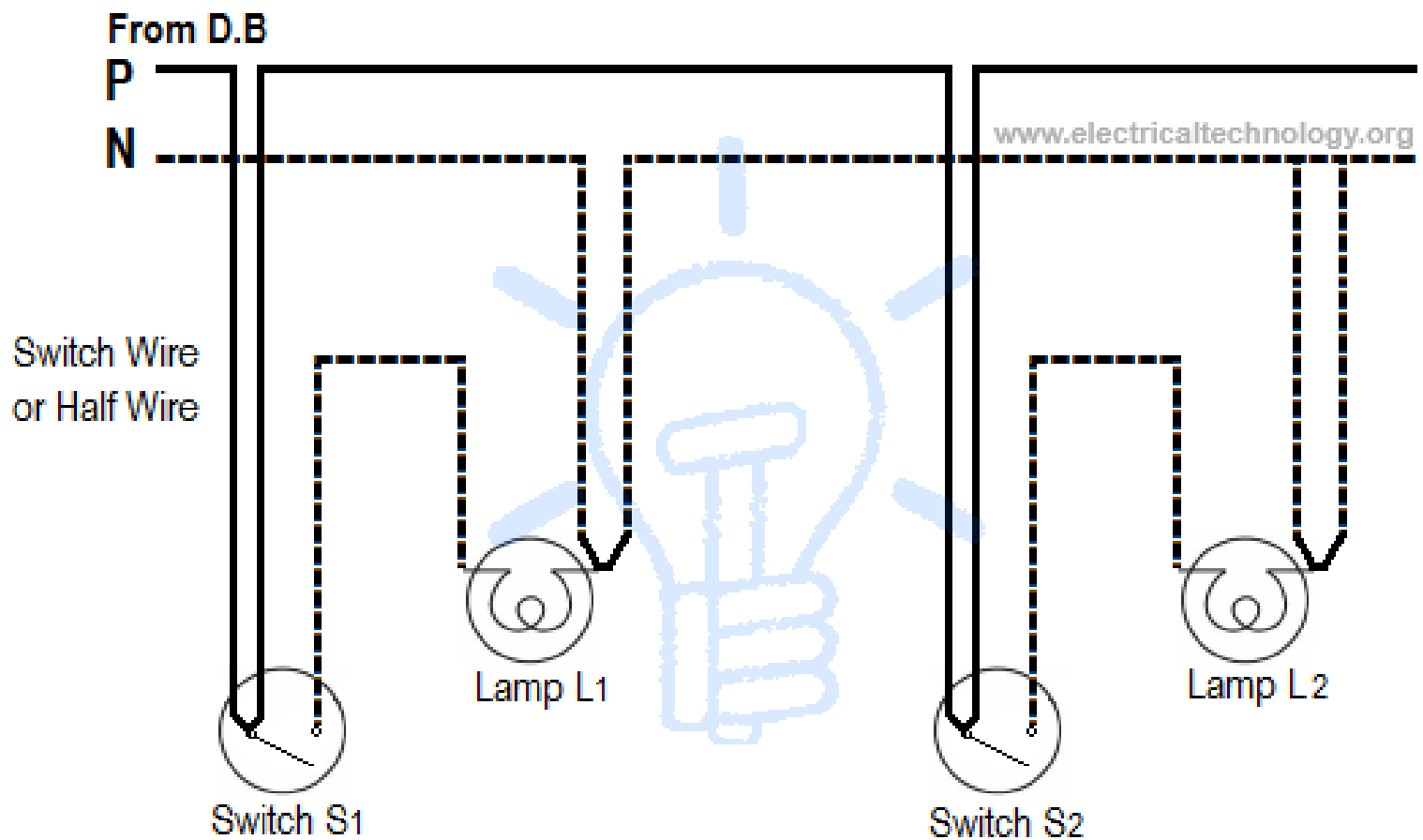
- Joint box system or Tee system
- Loop – in system

Based on internal wiring

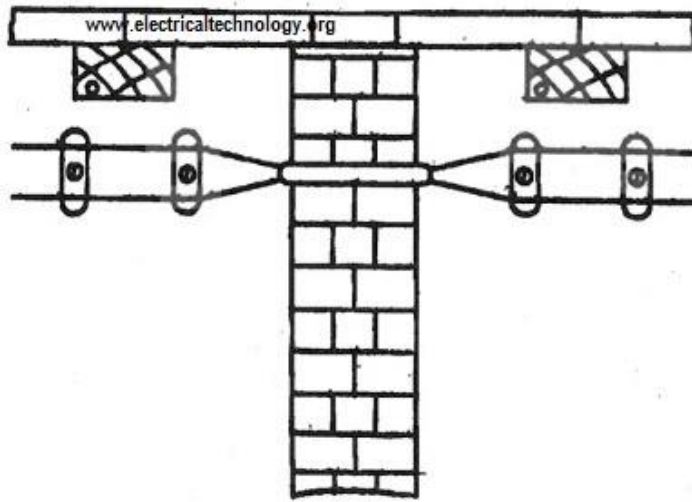
- Cleat wiring
- Wooden casing and capping wiring
- CTS or TRS or PVC sheath wiring
- Lead sheathed or metal sheathed wiring
- Conduit wiring



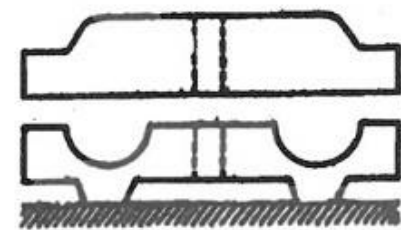
Joint Box System



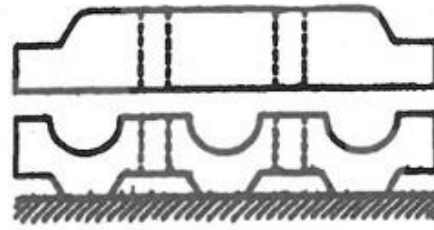
Loop-In System



Use of Wall tube, wires are drawn from one room into the other through partition wall.



i. Cleat with two grooves



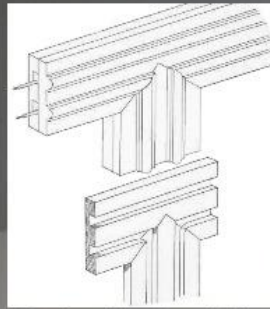
ii. Cleat with three grooves



Cleat Wiring

Cleat Wiring

- Most suitable for temporary use
- Inspection is easy and simple.
- Not suitable for sensitive location and places.
- Appearance is not so good.



Casing Capping Joints



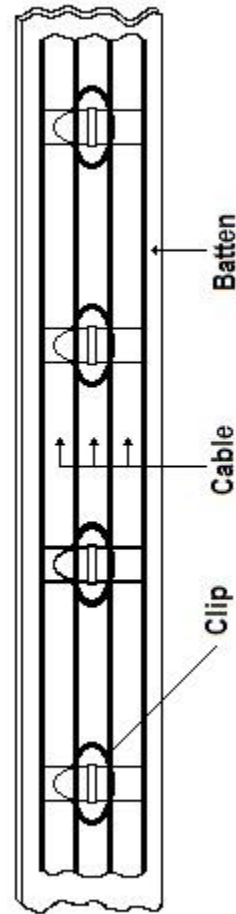
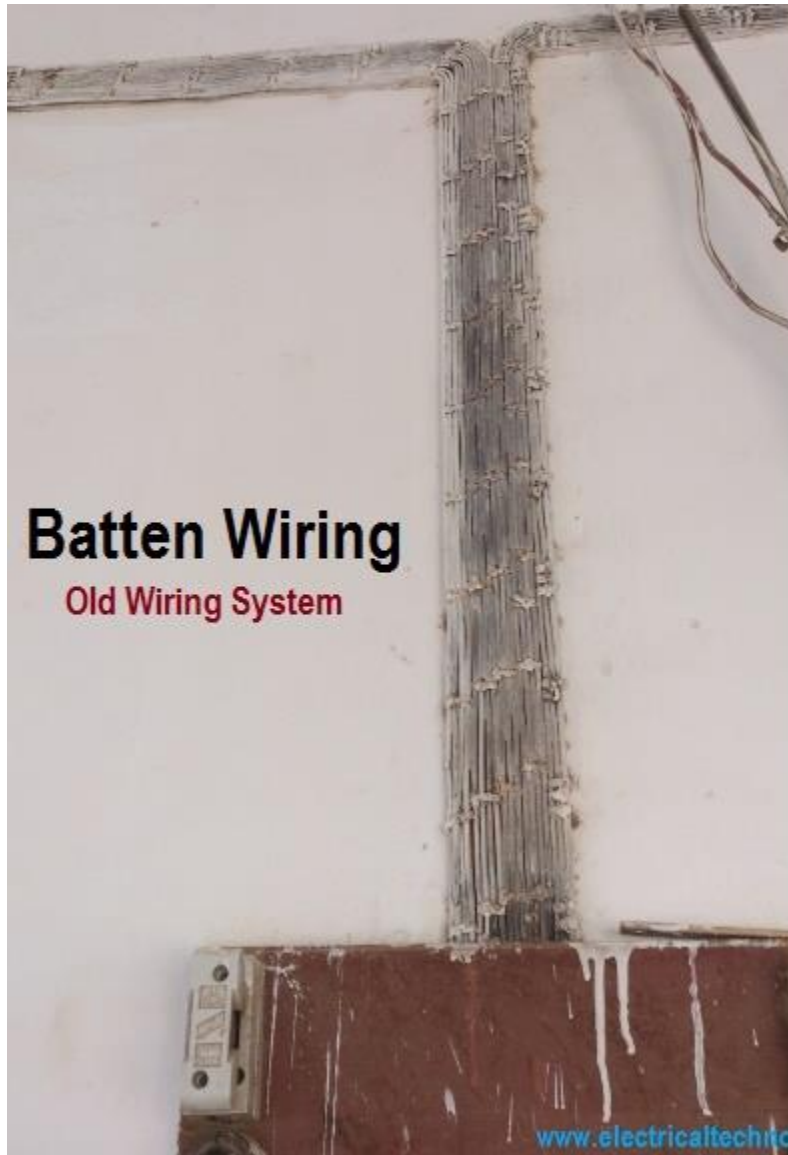
Casing & Capping Wiring



Casing & Capping Wiring

- Cheap, strong and long lasting
- Fire risk , not tamperproof

Batten Wiring



- Wiring installation is simple and easy
- High risk of fire
- Only suitable below 250V.
- Cheap

Lead Sheathed Wiring



- Suitable for underground cables
- conductors that are insulated
- covered with an outer sheath of lead aluminium alloy containing about 95% of lead.

Conduit Wiring

Surface Conduit Wiring

- conduits installed on roof or wall

Concealed Conduit Wiring

- conduits are hidden inside the wall slots with the help of plastering
- Professional wiring
- Cable protection
- Safest wiring



Non-metallic Conduit
(PVC)



Metallic Conduit Wiring (Steel)

Surface Conduit Wiring



www.electricaltechnology.org



Concealed Conduit wiring

Electrical wiring Accessories

Electrical Specific Hand Cutting Tools

Needle-nose pliers

- Forming loops on small conductors
- Cutting and stripping small conductors



Lineman's pliers (side cutters)

- Cutting large conductors
- Forming loops on large conductors
- Pulling and holding large conductors



Diagonal pliers (dykes)

- Cutting small conductors
- Cutting conductors in limited spaces



Wire strippers

- Stripping insulation from conductors
- Cutting small conductors
- Crimping wire lugs



Tools Used for Specialty Work

Steel fish tape and reel

- Pulling conductors through conduit
- Pulling cables through insulated walls



Conduit bender

- Bending conduit for conductor installation



Rotating speed screwdrivers

- Used for trim work, installing switch and receptacles



Sheet metal Cutters

- Used for cutting and trimming sheet metal



Wire Size Comparison



#16 top to #10 bottom



#2 top to #10 bottom

Wiring Diagrams

- Elements of a Good Wiring Diagram
 - Documents boat's electrical layout
 - Should be kept current
 - Used for troubleshooting
- Component Identification
 - Physical objects to their symbol
 - Wires are color coded

Wiring Diagram Symbols



Wire (insulated, metal conductor)



Wires crossing (but NOT connected)



Wires connected (at dots)



Battery (long line on top is positive)



Switch, single pole, single throw (SPST)



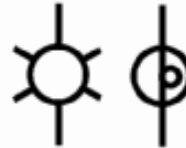
Switch, single pole, double throw (SPDT)



Switch, double pole, single throw (DPST)



Incandescent Light



Alternate symbol for Light



Circuit Breaker



Fuse



Ground

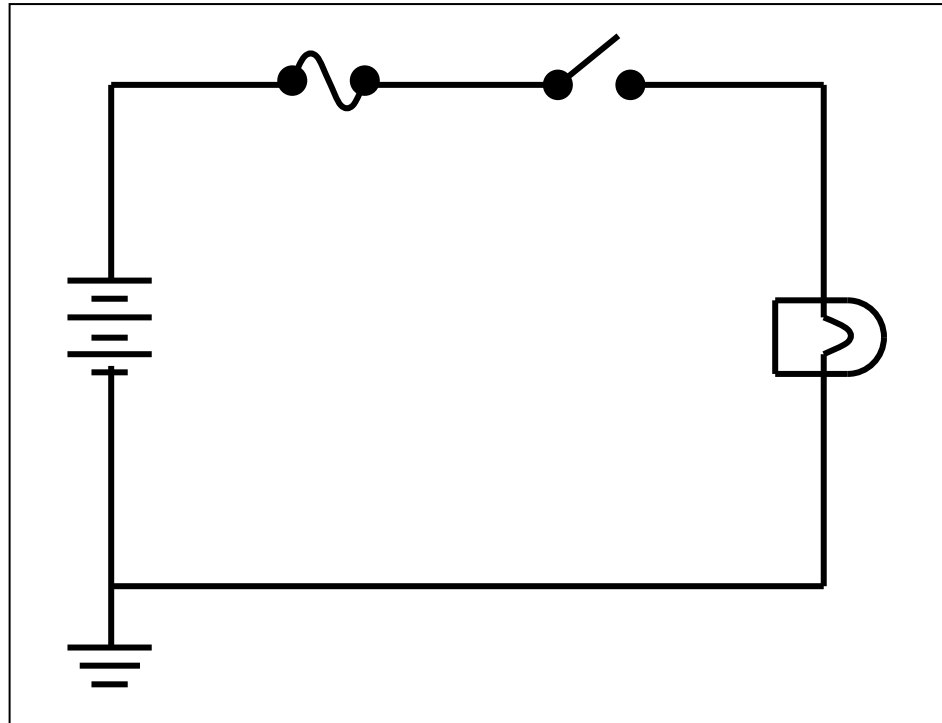


Male Connector



Female Connector

Simple DC Wiring Diagram



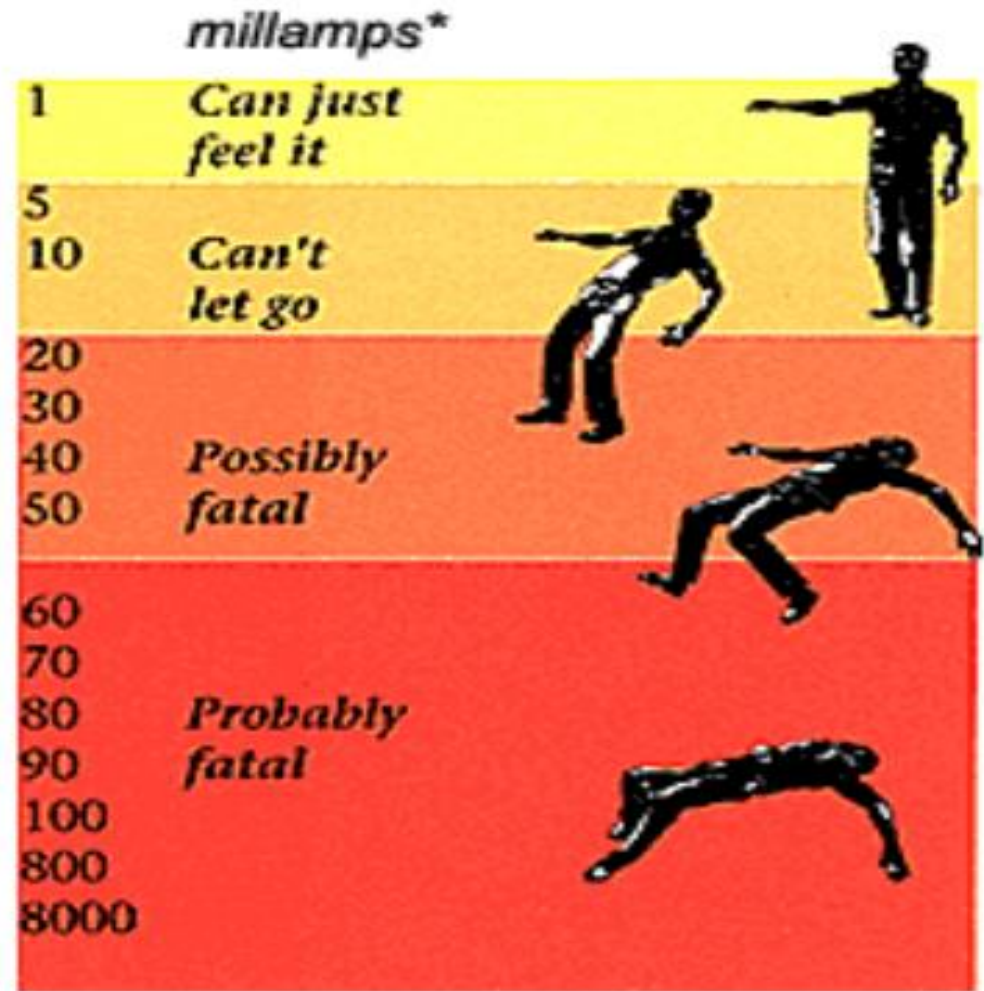
Safety

- Lethal Current
- Safety Precautions

Just a little current can kill

It is the
Current
driven through
the body
by **Voltage**
that creates
danger

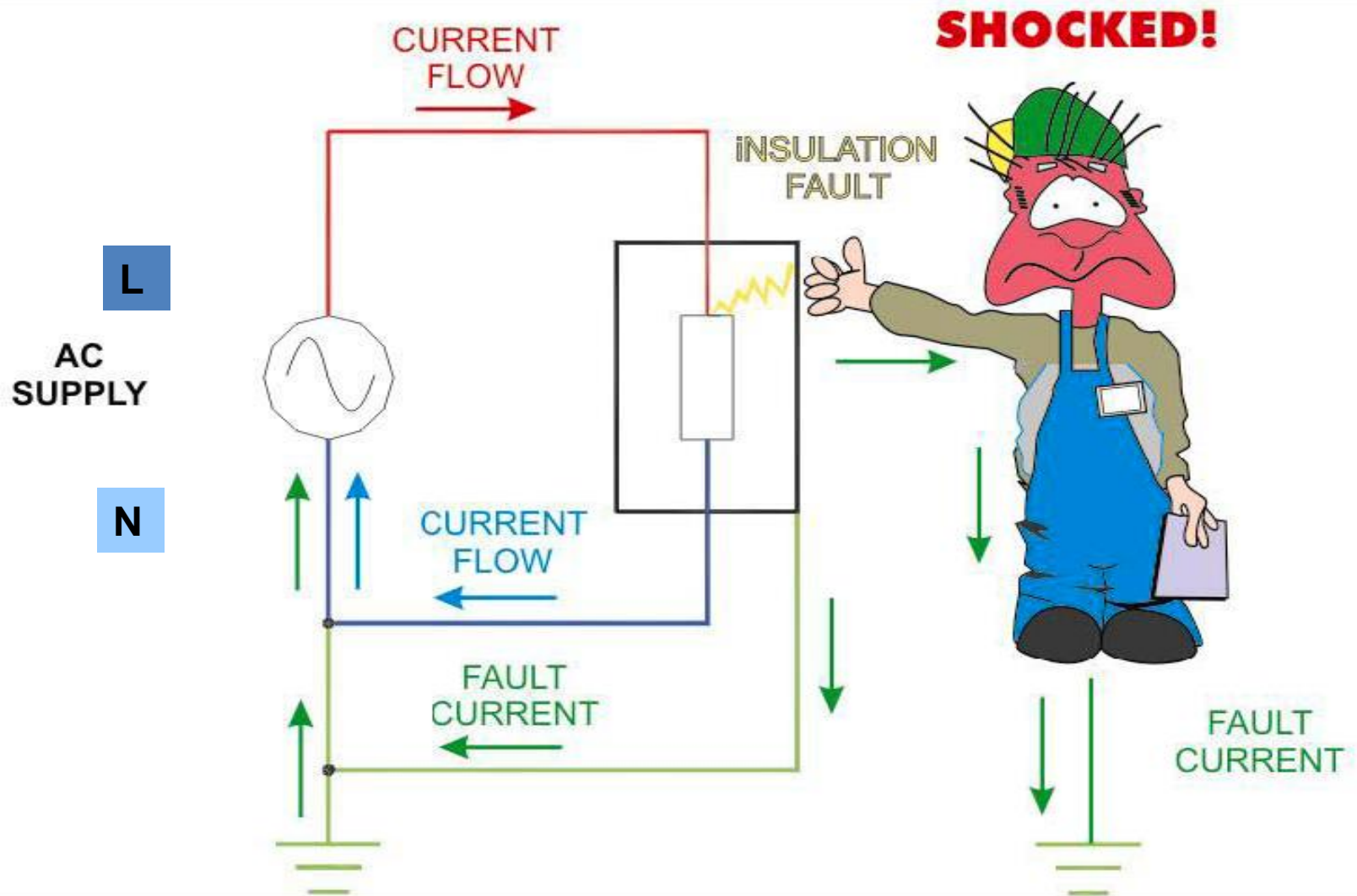
- Keep voltages low
- Do not make your body part of a circuit



Lethal Current

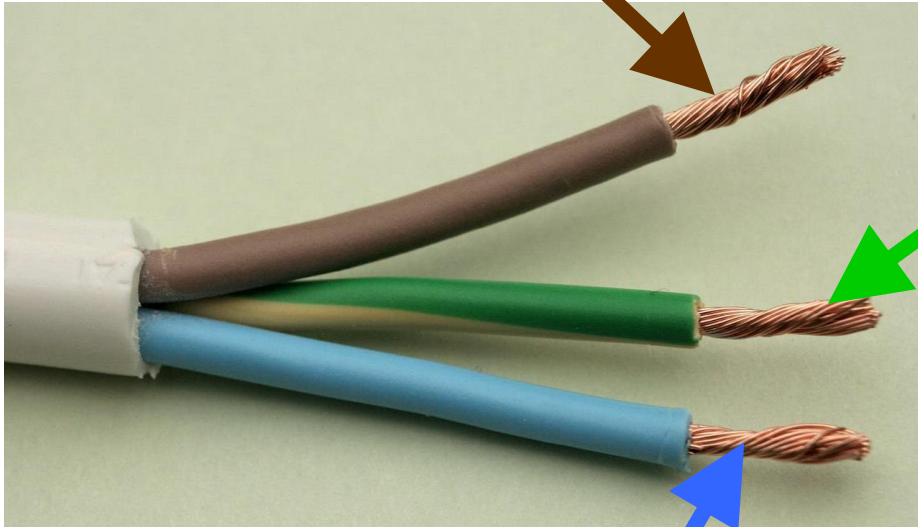
- Fundamental policy is **SAFETY**
- Human Body
 - Resistance – 4 K Ω (moist skin) to 24 K Ω (dry skin)
 - Safe current (through chest) – less than 20 milliamps
 - E = 120 VAC R = 4 K Ω I = ?
 - I = 30 milliamps - NOT SAFE
 - Don't want current through chest cavity (may be lethal)

Live, Neutral, Earth & Fuses



What does each wire do?

The **live wire** carries a current that alternates between a negative and positive voltage.



The **earth wire** is a safety wire that is needed to earth appliances with a metal case. This makes it safer to touch the appliance if it develops a fault.

The **neutral wire** completes the circuit. It is kept at a zero voltage by the electricity company.

Earth Wire

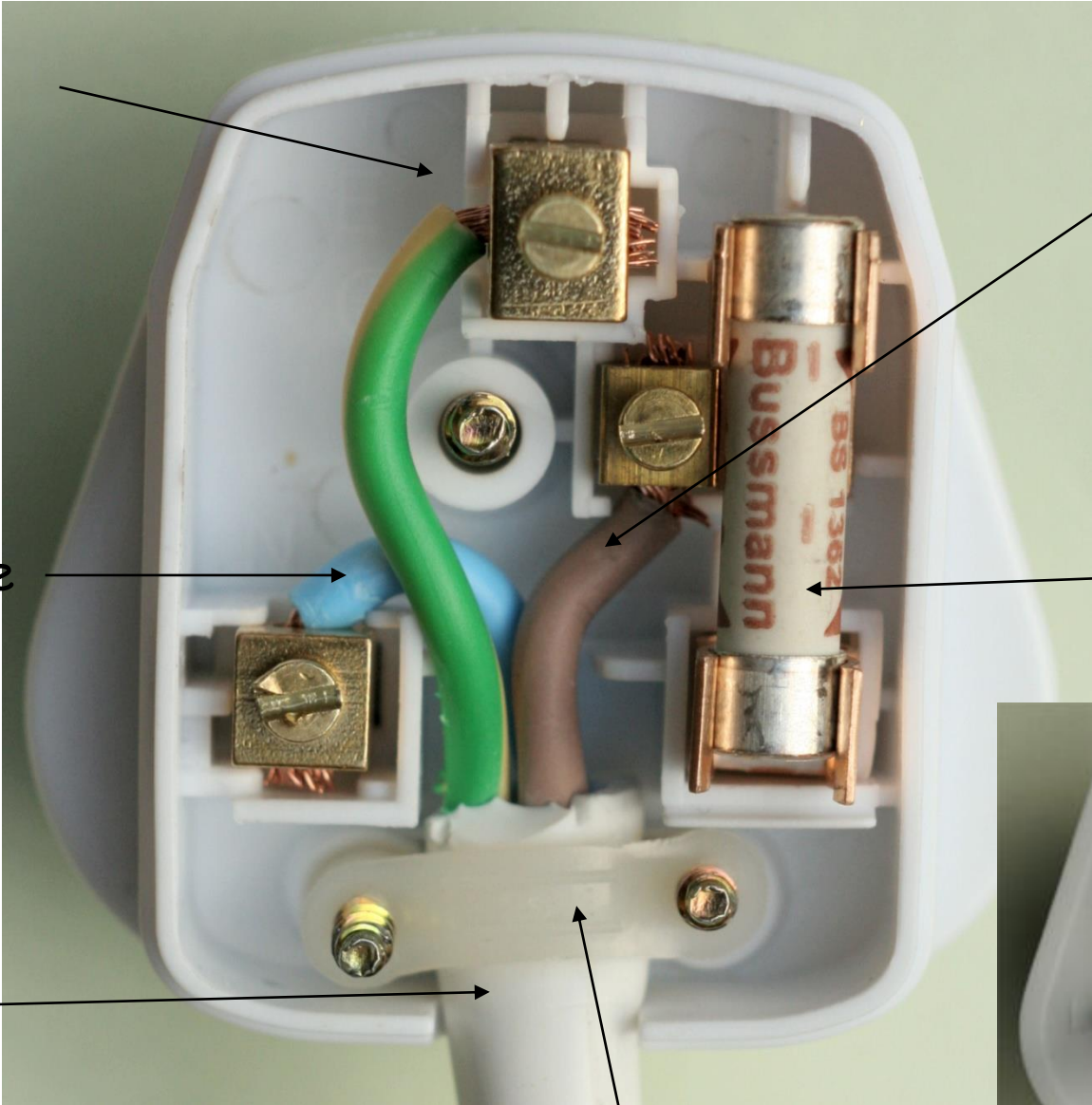
Live Wire

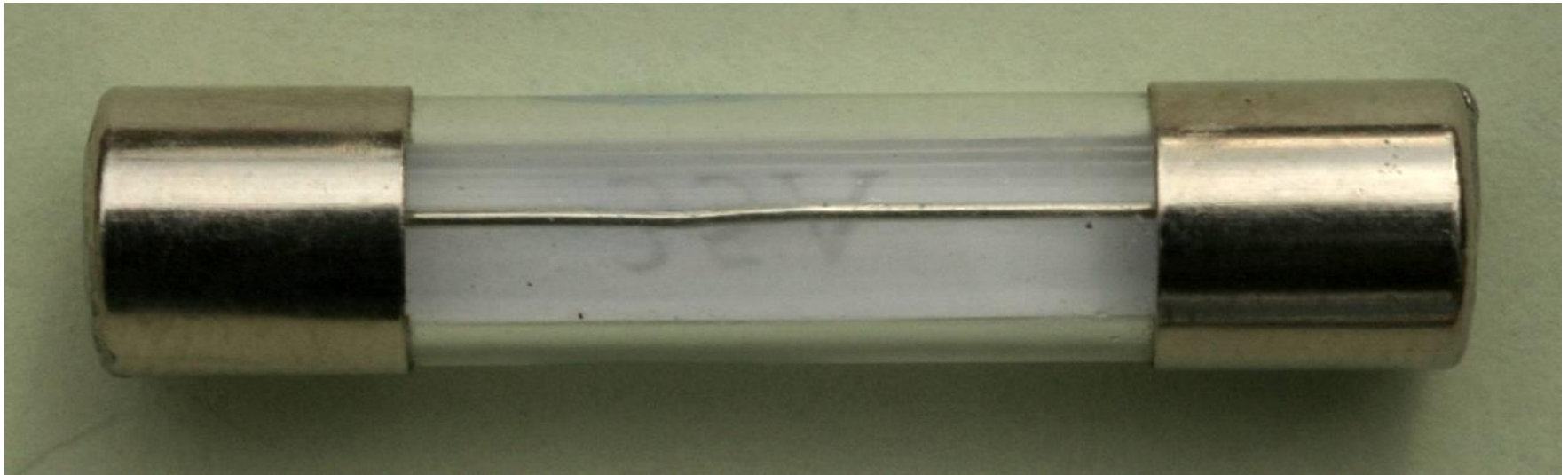
Neutral Wire

Fuse

Outer
Insulation

Cable Grip





The fuse does two jobs.

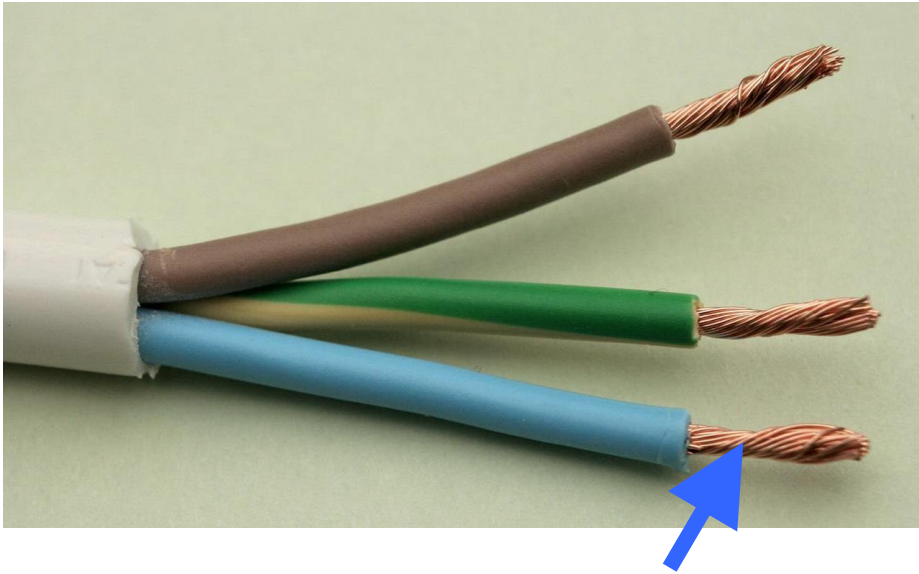
- It protects the wiring if something goes wrong.
- It can also protect us
- A fuse has a rating in amps (ie 13A) the rating of the fuse must be greater than the current used by a device



Safety Precautions

- Turn circuit off
 - Disconnect service cord
 - Disconnect negative battery cable
- If must work on live AC circuit
 - Need 2nd safety person
- Remove metal jewelry
- Know your system and its wiring
- Use outlet tester on AC outlets
- Use 3-wire extension cord from GFI outlet

What does each wire do?



Earthing Systems

A safe grounding design has two objectives:

1. To provide means to carry electric currents into the earth under normal and fault conditions without exceeding any operating and equipment limits or adversely affecting continuity of service.
2. To assure that a person in the vicinity of grounded facilities is not exposed to the danger of critical electric shock.

The PRIMARY goal of the grounding system throughout any facilities is SAFETY.

Why ground at all?

PERSONNEL SAFETY FIRST

EQUIPMENT PROTECTION SECOND

What are the different types of grounding?

Based on ground conductor:

- Plate earthing
- Pipe earthing
- Rod earthing

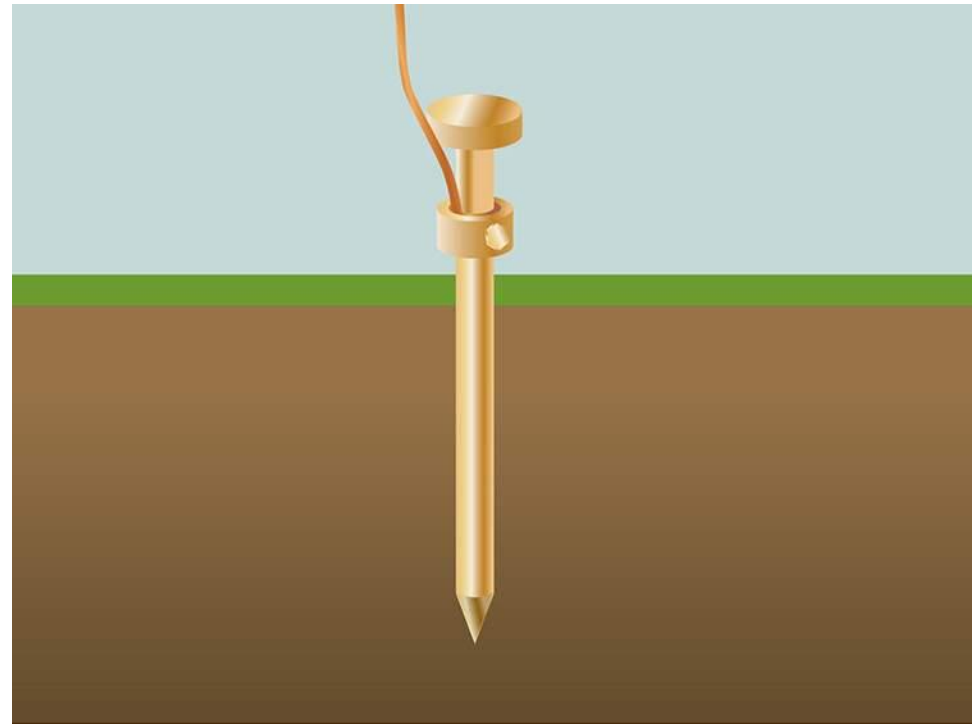
Based on application:

- Equipment grounding (safety)
- System grounding
- Lightning/surge grounding

Earth / Ground Basics

Types of Grounding Systems

- Many different types available
- Choice depends on local conditions and required function
- Simplest form is a single stake
- Mostly used for:
 - Lightning protection
 - Stand alone structures
 - Back-up for utility ground

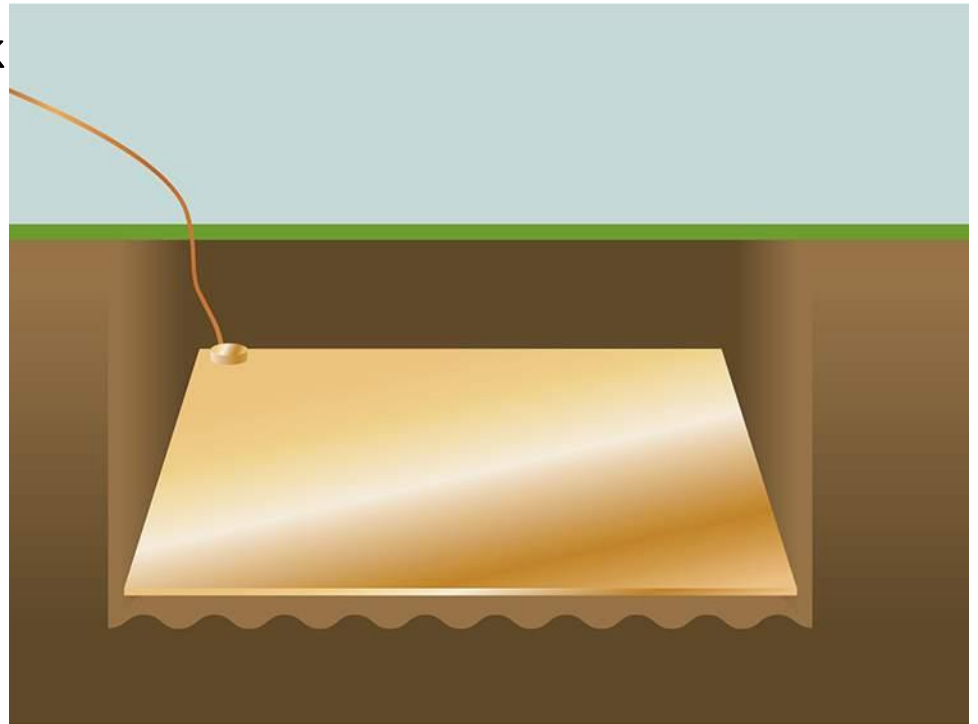


Ground rod

Earth / Ground Basics

Types of Grounding Systems

- For areas where there is rock (or other poor conducting material) fairly close to the surface ground plates are preferred as they are more effective



Ground plate

Earth / Ground Basics

Types of Grounding Systems

- Suitable for all types of earthing from domestic to industrial applications
- Cylindrical or rectangular pipes



Ground pipe

Recommended values of earth resistance

system	Recommended earth resistance(ohm)
Light current	0.5-1
Low voltage	5
Medium voltage	2.5
High voltage	0.5

Earth clamping 1



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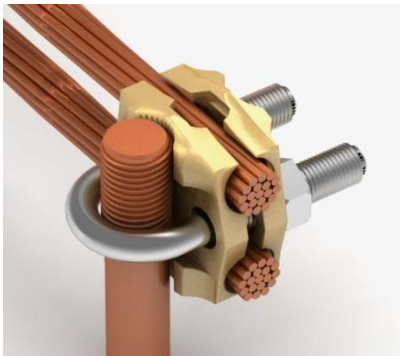
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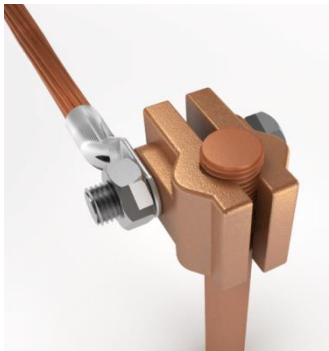
Earth clamping 2



AT-087J



AT-089J



AT-093J



***Treat electricity with
the respect it demands,
and it will serve you
efficiently and
effectively***



Summary

Layout . of distribution



Wiring

Accessories

Safety



Earthing .

Done !!