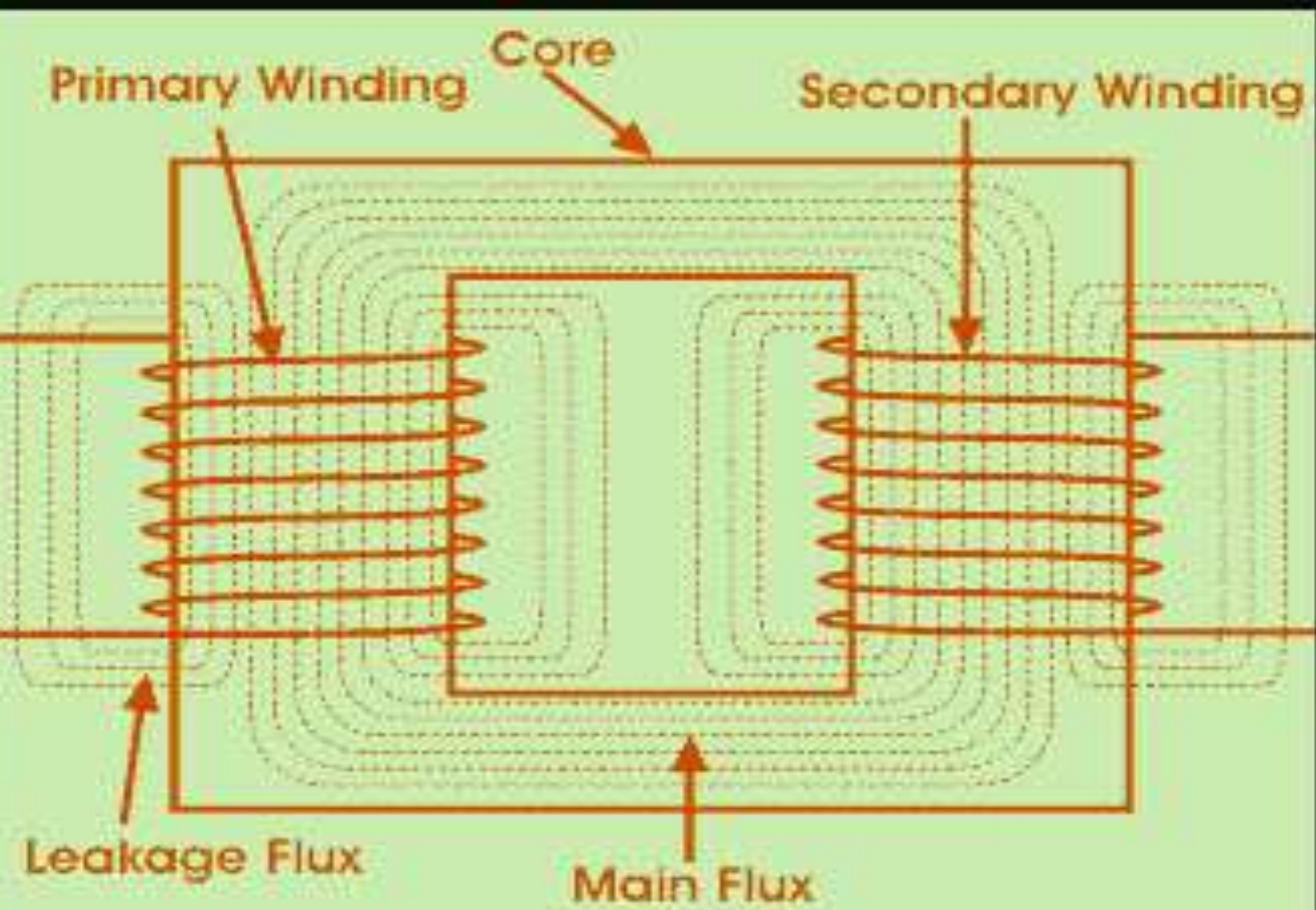


TRANSFOMIER

- TRANSFORMER”- one of oldest innovations in Electrical Engineering.
- A Transformer is an electrical device that can be used to transfer the power from one circuit and another circuit without physical contact and without changing its characteristics like frequency, phase. It is an essential device in every electrical network circuitry.



Working Principle of Transformer

- The transformer working depends upon Faraday's electromagnetic induction law.
- $E = N \frac{d\phi}{dt}$
E = Induced EMF
N = the number of turns
 $d\phi$ = Change in flux
dt = Change in time

Types of Transformers

- ◉ The transformers are classified based on
 - voltage levels,
 - Core medium used,
 - winding arrangements,
 - use and installation place,

Transformers Based on Voltage Levels

- These are the most commonly used transformer types for all the applications.
- Depends upon the voltage ratios from primary to secondary windings, the transformers are classified as step-up and step-down transformers.

Step-Up Transformer

- As the name states that, the secondary voltage is stepped up with a ratio compared to primary voltage.
- This can be achieved by increasing the number of windings in the secondary than the primary windings.
- In power plant, this transformer is used as connecting transformer of the generator to the grid.

Step-up Transformer

Iron Core

Input
Voltage



Primary
Coil
(Input)



Secondary
Coil
(Output)



Output
Voltage

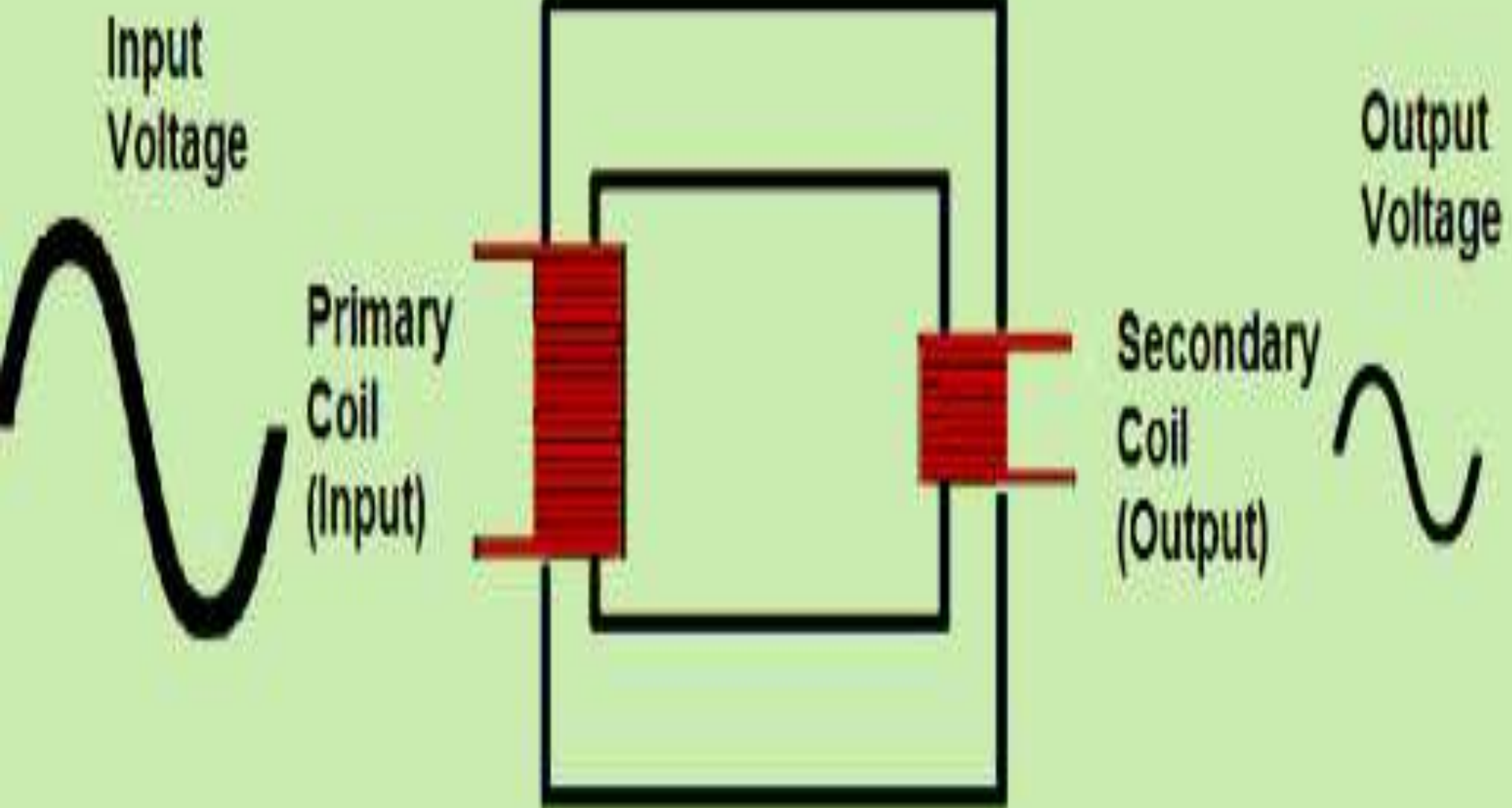


Step-Down Transformer

- It is used to step down the voltage level from higher to lower level at secondary side as shown below so that it is called as a step-down transformer.
- The winding turns more on the primary side than the secondary side.

Step-Down Transformer

Iron Core



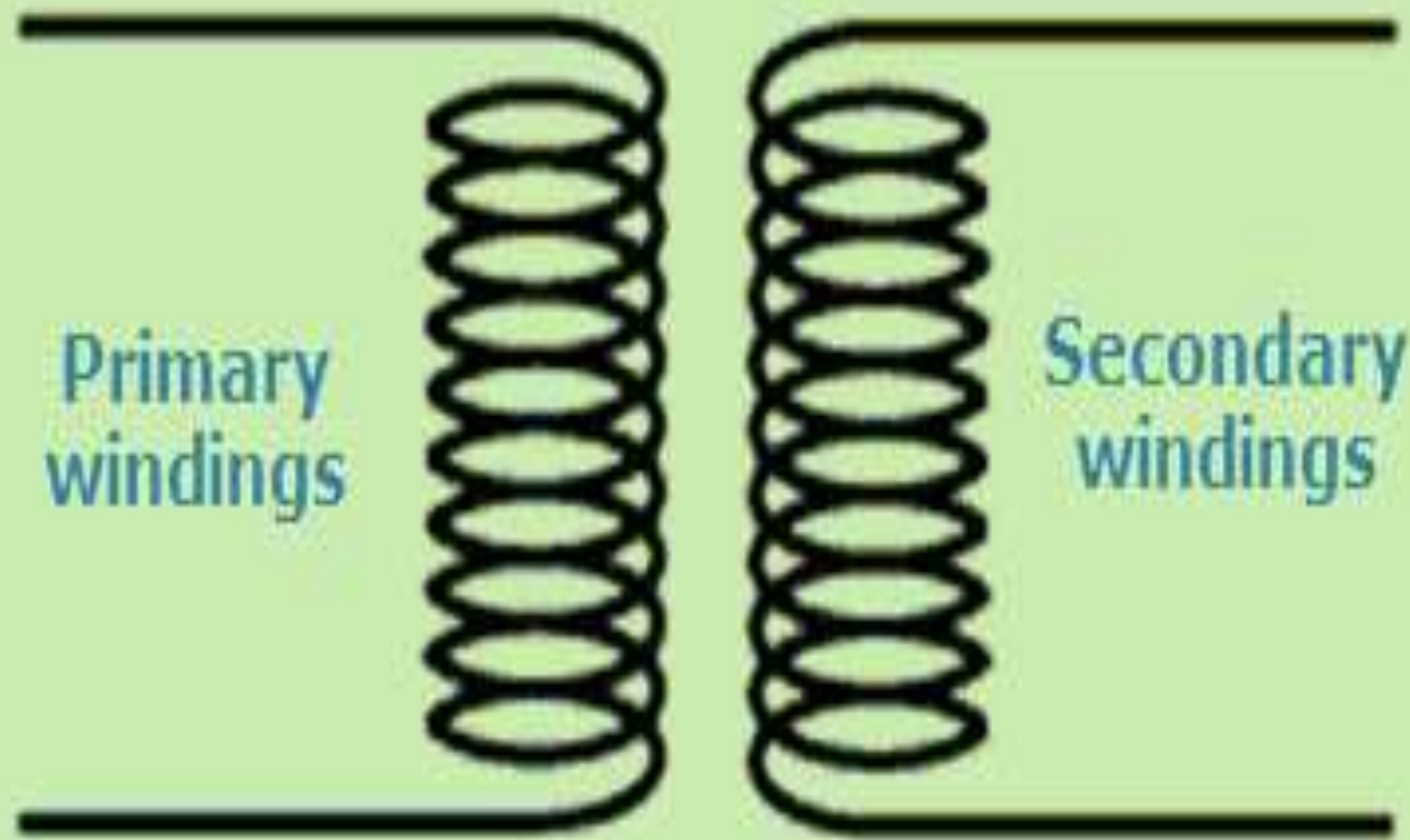
Transformer Based on the Core Medium Used

- Based on the medium placed between the primary and secondary winding the transformers are classified as
Air core and Iron core

Air Core Transformer

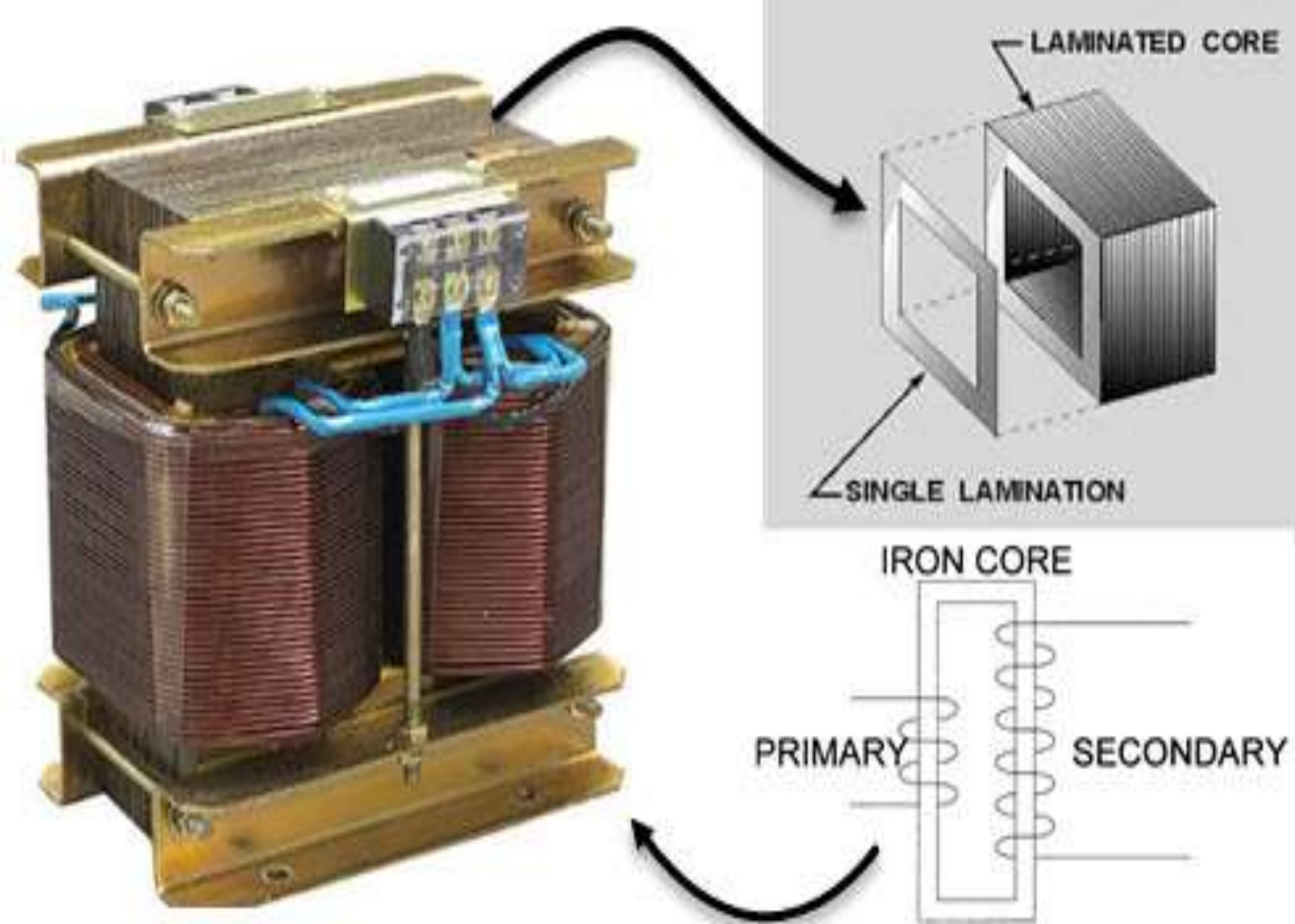
- Both the primary and secondary windings are wound on a non-magnetic strip where the flux linkage between primary and secondary windings is through the air.

Air Core Transformer



Iron Core Transformer

- Both the primary and secondary windings are wound on multiple iron plate bunch which provide a perfect linkage path to the generated flux.
- It offers less reluctance to the linkage flux due to the conductive and magnetic property of the iron.
- These are widely used transformers in which the efficiency is high compared to the air core type transformer.

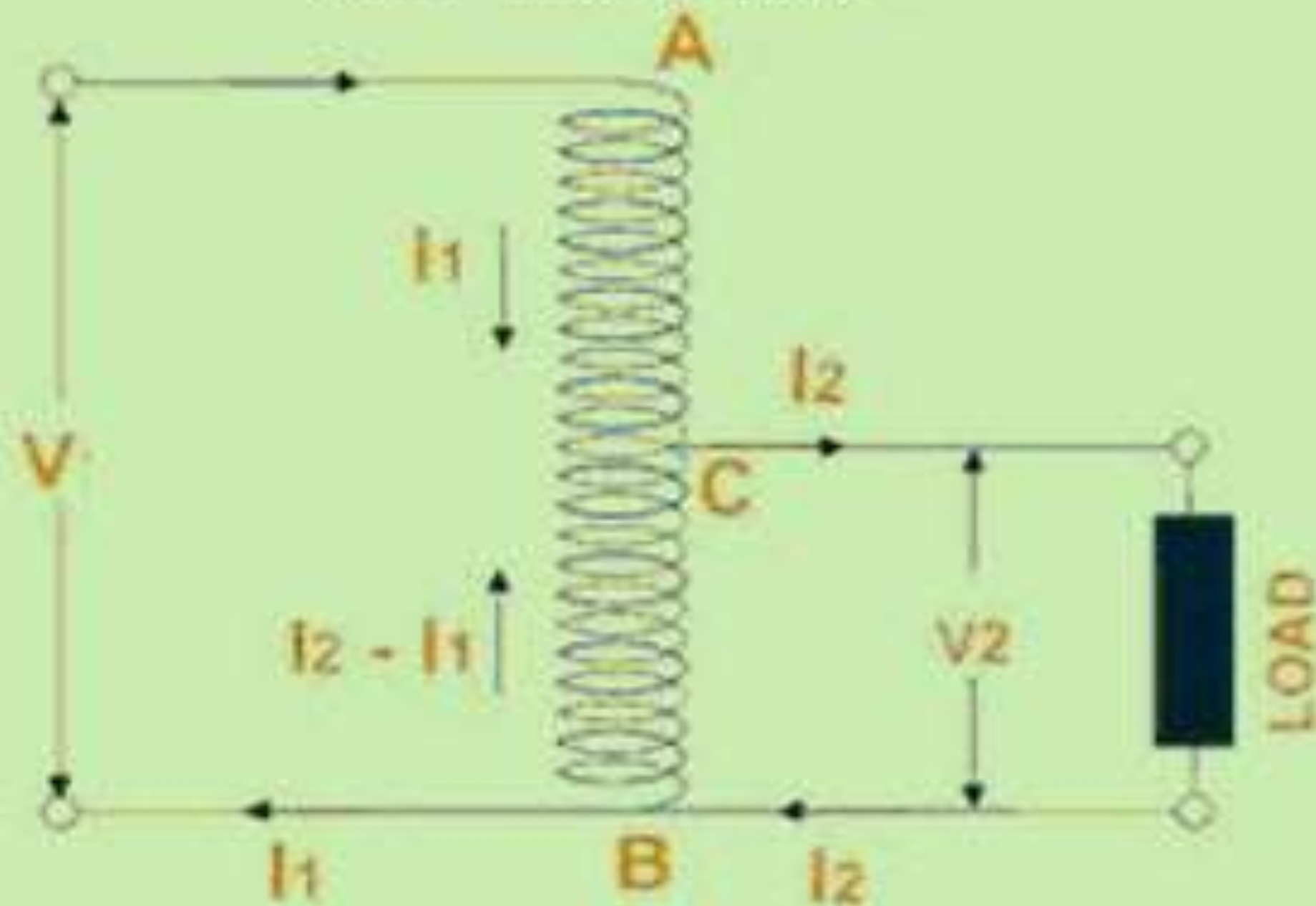


Transformers Based on Winding Arrangement

- **Auto Transformer**

- Standard transformers have primary and secondary windings placed in two different directions, but in autotransformer windings, the primary and the secondary windings are connected to each other in series both physically and magnetically as shown in the figure below.

Auto Transformer

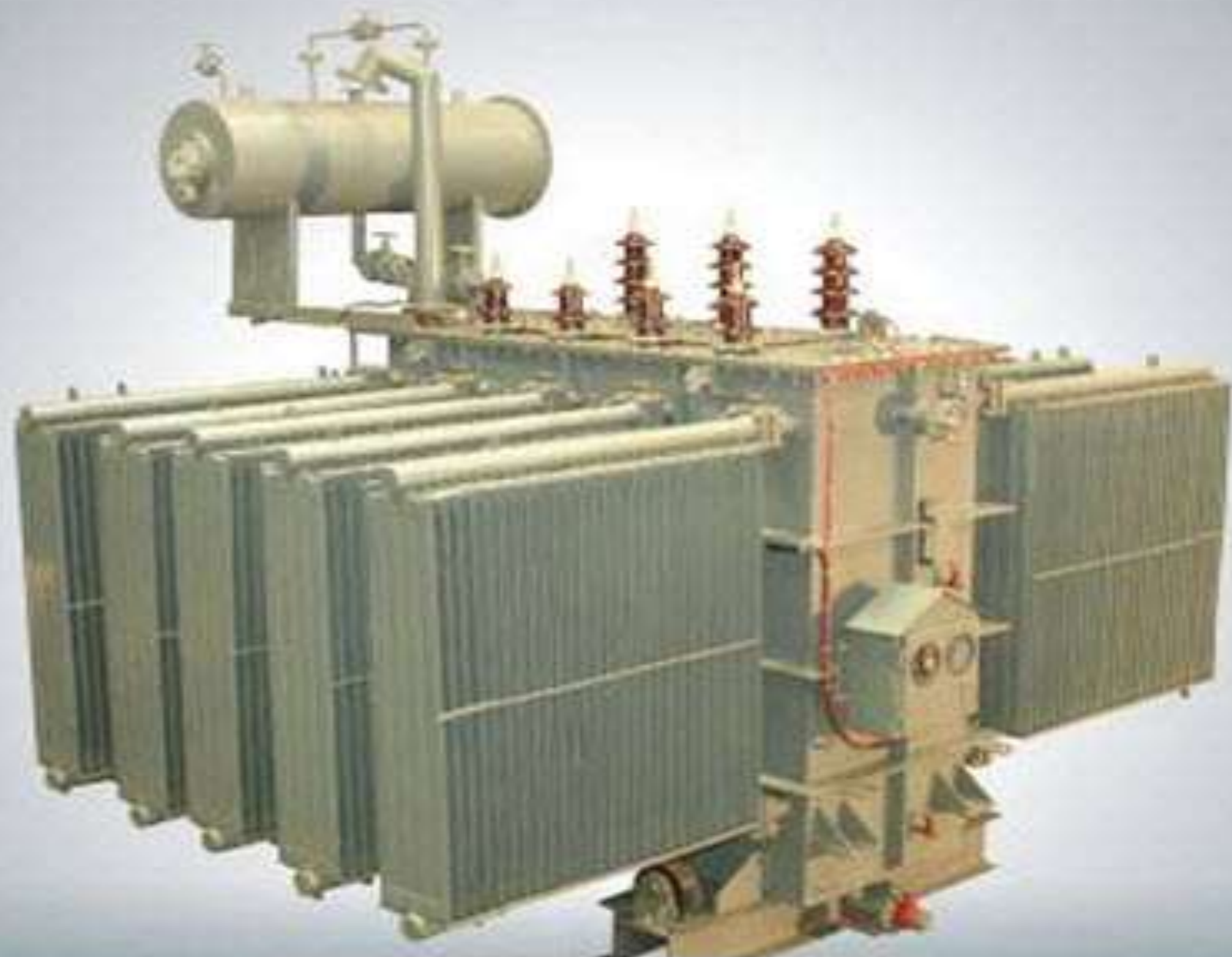


Transformers Based on Usage

- According to the necessity, these are classified as the power transformer, distribution transformer measuring transformer, and protection transformer.

Power Transformer

- The power transformers are big in size. They are suitable for high voltage (greater than 33KV) power transfer applications. It used in power generation stations and Transmission substation. It has high insulation level.



10 MVA, 33/11 KV, Power Transformer

Measurement Transformer

- Measurement transformer is often referred to as an instrument transformer.
- This is another commonly used measurement instrument in the power domain.
- A measurement transformer is used to isolate the main power and convert the current and voltage in a smaller ratio to its secondary output.
- By measuring the output, the Phase, Current and Voltage of the actual power line can be measured.



Distribution Transformer

- In order to distribute the power generated from the power generation plant to remote locations, these transformers are used.
- Basically, it is used for the distribution of electrical energy at low voltage is less than 33KV in industrial purpose and 440v-220v in domestic purpose.

- ◉ It works at low efficiency at 50-70%
- ◉ Small size
- ◉ Easy installation
- ◉ Low magnetic losses
- ◉ It is not always fully loaded

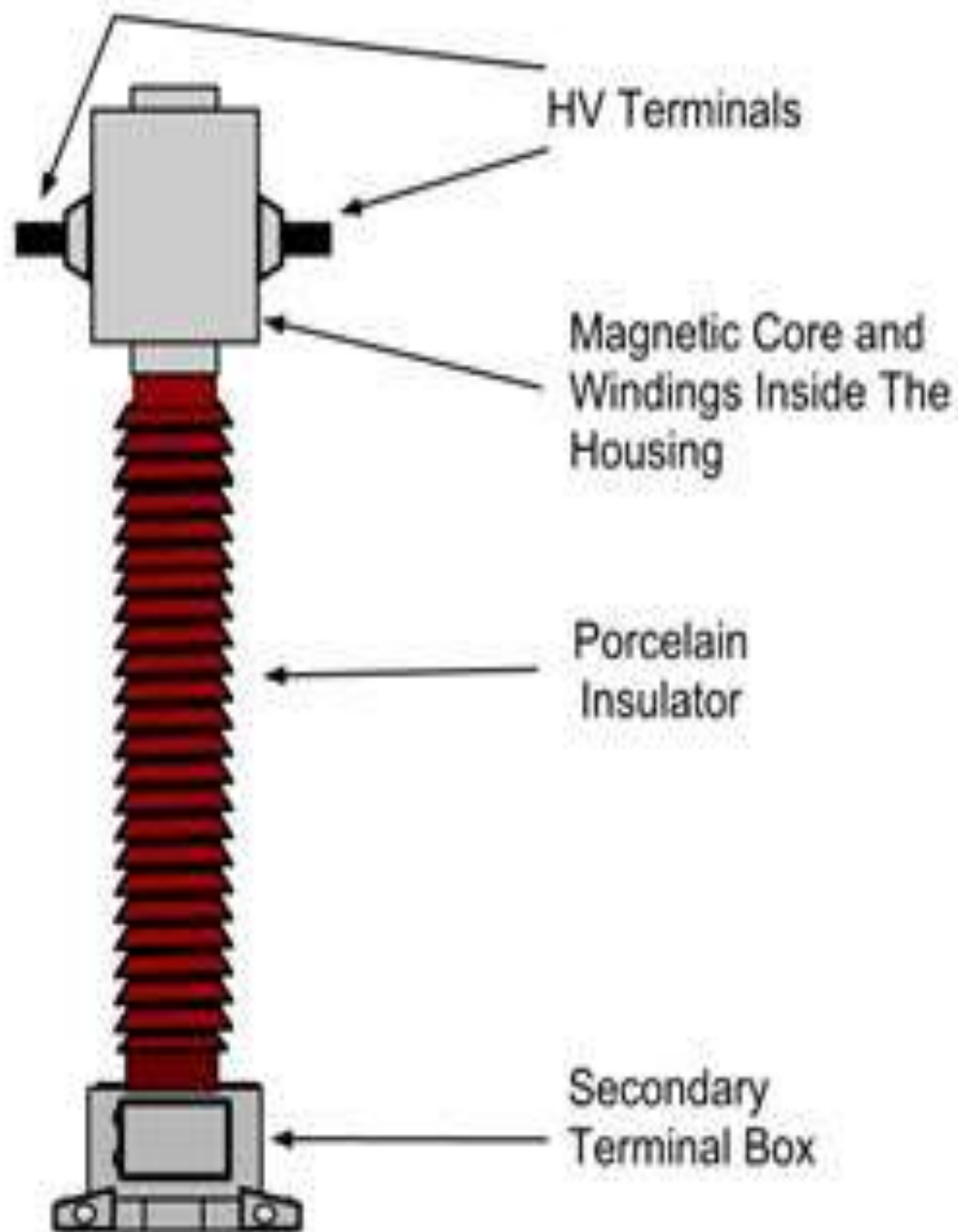


Measurement Transformer

- They are classified into
CURRENT TRANSFORMER
POTENTIAL TRANSFORMER

current transformer

- A **current transformer (CT)** is a type of transformer that is used to measure alternating current (AC). It produces a current in its secondary which is proportional to the current in its primary.



Protection Transformers

- This type of transformers is used in component protection purpose.
- The major difference between measuring transformers and protection transformers is the accuracy that means that the protection transformers should be accurate as compared to measuring transformers.



UNILIZED TRANSPORTABLE SUBSTATION

- ◉ Unitized Transportable Substation is used for feeding power from high voltage to low voltage in open cast mines, construction sites, metro cities, etc.
- ◉ The substation is compact in size, suitable for frequent shifting and for use in outdoor locations.
- ◉ The substation is installed and mounted on skid frame or wheels or channels and is provided with lifting hooks

- ◉ **Available in both Indoor/Outdoor Versions**
- ◉ Compact
- ◉ Safe, as the transformers used are dry, cast resin type
- ◉ Fully compartmentalized, no accidental access to live parts
- ◉ Transportable & Ready to install
- ◉ Minimal Maintenance

ADVANTAGES

- The USS can be placed in the basement or ground floor or on roof top of the high rise building.
- USS enclosure design is such that care has been taken to vent out the heat generated in the transformer cubicle.
- Indoor USS located at the basement of high-rise buildings, natural ventilation is more than adequate for cooling.
- However, in places where natural cooling is insufficient, forced cooling with fans can be provided on request.
- USS can also be installed at construction sites, exhibitions, open cast mines as mobile substation, either on truck or skid mounted.

Dry transformer

- **Dry type transformer** never uses any insulating liquid where its winding with core be immersed. Rather windings with core are kept within a sealed tank that is pressurized with air.

Type of Dry Type Transformer

- The dry type transformer is of two types.
They are
 - 1 .Cast Resin Dry Type Transformer (CRT)
 - 2 .Vacuum pressure Impregnated Transformer (VPI)

Cast Resin Dry Type Transformer (CRT)

- Cast resin dry type transformer (CRT) is used in the high moisture prone areas.
- It is because of its primary and secondary windings are encapsulated with epoxy resin.
- This encapsulation helps to prevent moisture to penetrate to affect the winding material.
- Complete protection is achieved by this cast resin encapsulation so that the transformer can work without disruption in highly moisture prone area. Thus this transformer is non hygroscopic.

- ⦿ This type of transformer is available in ratings of 25 KVA to 12,500 KVA. with insulation class of F (90°C Temp. Rise).

This type of transformer has some featured advantages. They are-

- ⦿ Better over load capacity.
- ⦿ Low partial discharge along with low loss. Hence efficiency is very good.
- ⦿ As it is with non inflammable winding insulation, it offers zero risk to fire hazard. So it is suitable for indoor installation.
- ⦿ Can be fitted outdoor in IP 45 enclosure.
- ⦿ And off course non hygroscopic.

Vacuum Pressure Impregnated Transformer (VPI)

- This type of transformer is made with minimum flammable material as insulation of windings.
- The windings of this transformer are made in foil or strip in a continuous layer. But for higher voltages, the winding is made of disks that are connected in series or parallel as per power rating with respect to voltage level.

- The insulation of the winding is void free impregnation that is made with class H polyester resin. The primary and secondary winding with core are laced safely within a vacuum protective box. Moisture Ingress Protection is high and it never gets affected by moisture.
- This type of transformer is available from 5KVA to 30MVA with insulation grade F(155°C) and H(180°C). It's with Protection up to IP56.

- ⦿ This type of transformer has several advantages. They are-
- ⦿ High mechanical strength.
- ⦿ Void free insulation.
- ⦿ No temperature fluctuation.
- ⦿ Easy maintenance.
- ⦿ Less prone to fire hazard.

Dry type Transformer



Advantages of Dry Type Transformer

The main advantages of **dry type transformer** are given below.

- Safety for people and property.
- Maintenance and pollution-free solution.
- Easy installation.
- Side clearance is less.
- Environmentally friendly.
- Excellent capacity to support overloads.
- Reduced cost on civil installation works and fire protection systems.
- Excellent performance in case of seismic events.
- No fire hazard.
- Excellent resistance to short circuit currents.
- Long lasting due to low thermal and dielectric heating.
- Suited for damp and contaminated areas.

Disadvantages of Dry Type Transformer

But there are some disadvantages of dry type transformer. They are-

- ◉ Dry type transformer is long lasting and with less chance of winding failure. But once it fails whole set up is to be changed, i.e. complete change of high voltage and low voltage winding with limb.
- ◉ For same power and voltage rating, dry type transformer is costlier than oil cooled transformer.

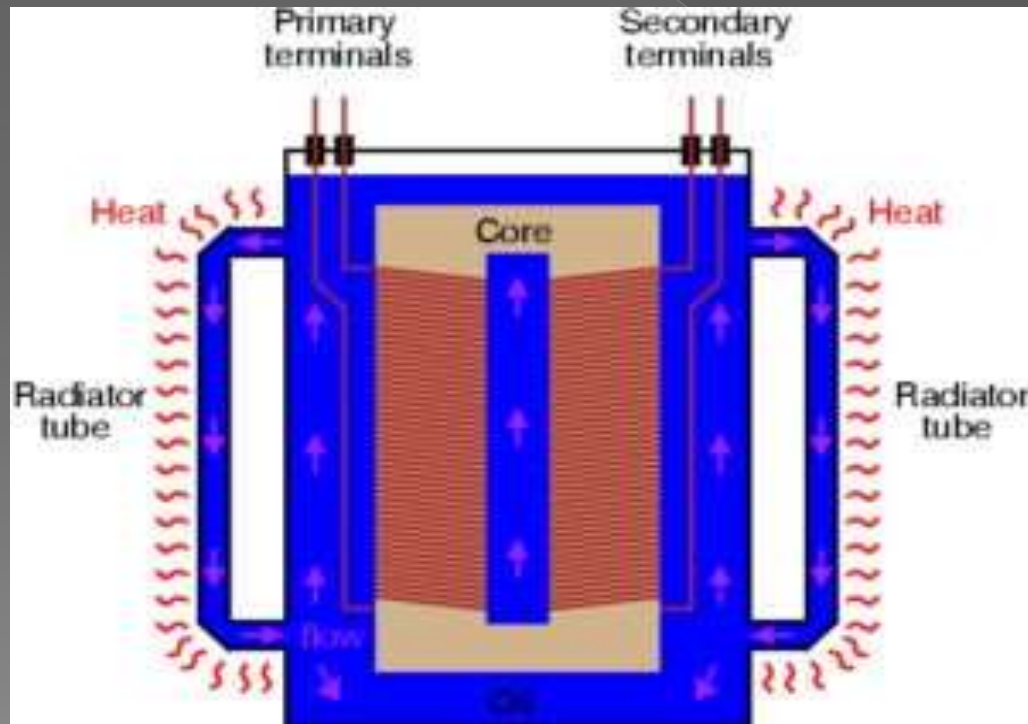
Application of Dry Type Transformer

- ◉ Dry type transformer are widely used in-
- ◉ Chemical, oil and gas industry
- ◉ Environmentally sensitive areas (e.g. water protection areas)
- ◉ Fire-risk areas (e.g. forests)
- ◉ Inner-city substations
- ◉ Indoor and underground substations
- ◉ Renewable generation (e.g. off-shore [wind turbines](#))

Oil transformer

- ◉ Transformer oil is used in the oil filled transformer and in some other system such as high voltage capacitors, fluorescent lamp ballasts, circuit breaker etc.
- ◉ Basic requirement of transformer oil is that it should be stable at high temperatures with excellent electrical insulating properties and suitable cooling property

- ◉ **Standard for transformer oil**
- ◉ How transformer oil is used in the liquid type transformer
- ◉ Core and windings of liquid cooled power transformer is submerged with transformer oil.



Function of transformer oil

- ◉ Following are the function of transformer oil
- ◉ As Electrical insulation media
- ◉ As Cooling media (transfer heat to the wall of tank/ conservator).
- ◉ Suppression of arcing & corona.

Types of transformer oil

- Highly refined mineral oil.(Mostly used)
- Silicone-based oil, fluorinated hydrocarbons (high fire resistant but costly then mineral oil)
- Pentaerythritol tetra fatty acid, natural and synthetic esters (low flammable, environment friendly, high moisture tolerance than that of mineral oil)
- Vegetable-based oils (Unsuitable for cold environment)

