Transformers

Transformer

An A.C. device used to change high voltage low current A.C. into low voltage high current A.C. and vice-versa without changing the frequency

In brief,

1. Transfers electric power from one circuit to another

2. It does so without a change of frequency

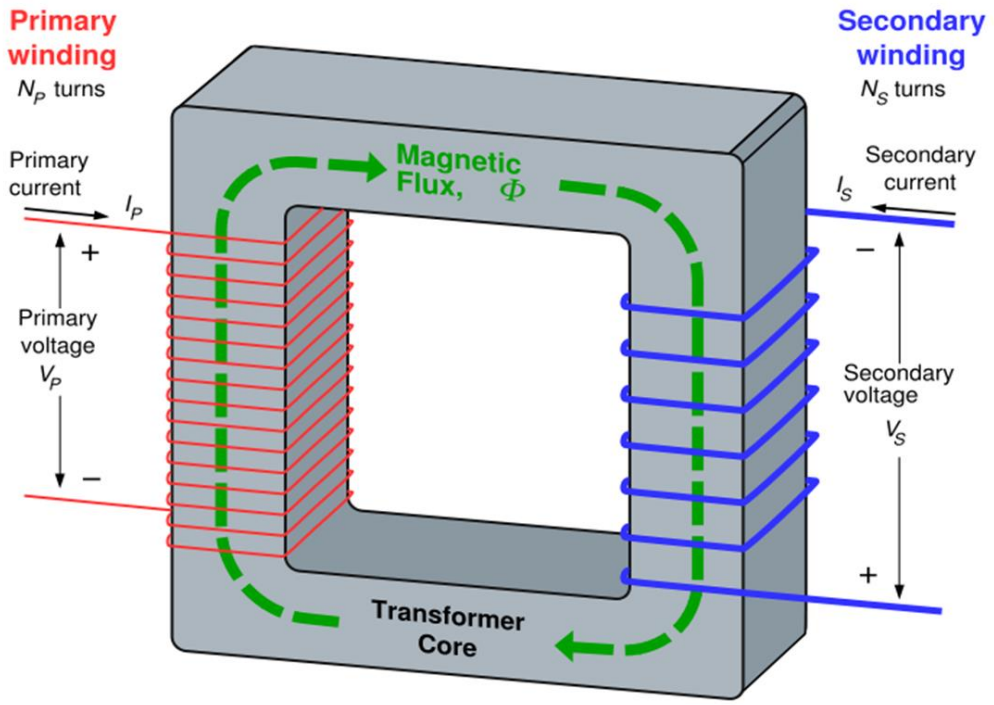
3. It accomplishes this by electromagnetic induction

4. Where the two electric circuits are in mutual inductive influence of each other.

Construction of Transformer

Basically a transformer consists of a

1. A primary coil or winding.
2. A secondary coil or winding.
3. A core that supports the coils or the windings



- The transformer two inductive coils ,these are electrical separated but linked through a common magnetic current circuit
- These two coils have a high mutual induction
- One of the two coils is connected of alternating voltage .this coil in which electrical energy is fed with the help of source called primary winding (P) shown in fig.

- The other winding is connected to a load the electrical energy is transformed to this winding drawn out to the load .this winding is called secondary winding(S) shown in fig.

The primary and secondary coil wound on a ferromagnetic metal core

The function of the core is to transfer the changing magnetic flux from the primary coil to the secondary coil

The primary has N1 no of turns and the secondary has N2 no of turns the of turns plays major important role in the function of transformer

Magnetic core

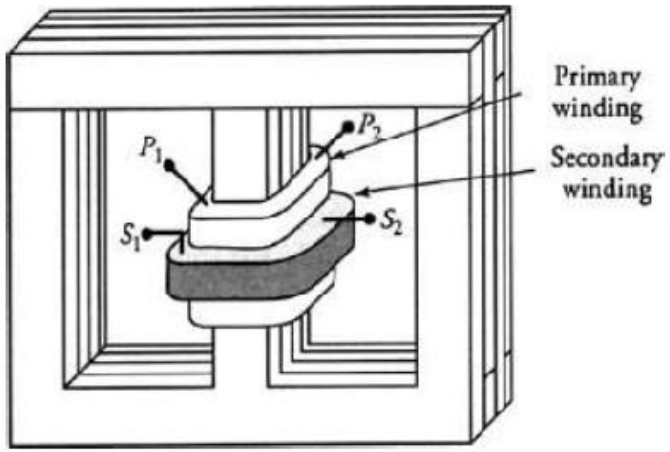
The core of transformer either square or rectangular type in size

It is further divided into two parts vertical and horizontal

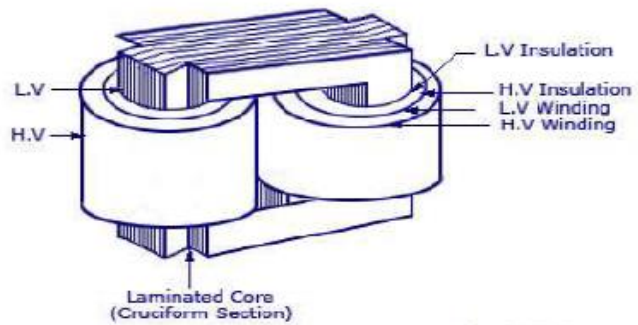
The vertical portion on which coils are wounds called limb while horizontal portion is called yoke. these parts are

Core is made of laminated core type constructions, eddy current losses get minimize.

Generally high grade silicon steel laminations (0.3 to 0.5mm) are used



Core Type Transformer Cruciform Section



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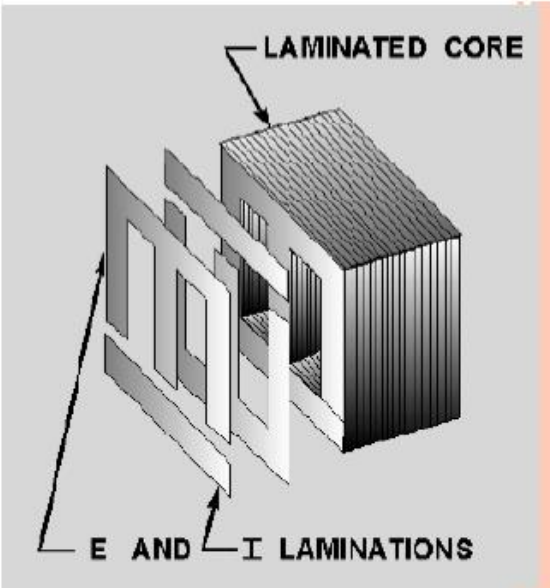


WINDING

- Conducting material is used in the winding of the transformer
- The coils are used are wound on the limbs and insulated from each other
- The two different windings are wounds on two different limbs
- The leakage flux increases which affects the performance and efficiency of transformer
- To reduce the leakage flux it is necessary that the windings should be very close to each other to have high mutual induction

Bushing
Connection of winding are (copper rod or bus bar) taken to bushing.

Insulating materials
Insulating materials like papers and card boards are used to isolate primary and secondary windings from each other as well as the transformer core. These windings are made of copper due to high conductivity and ductility. High conductivity minimizes the amount of copper needed and minimizes losses.

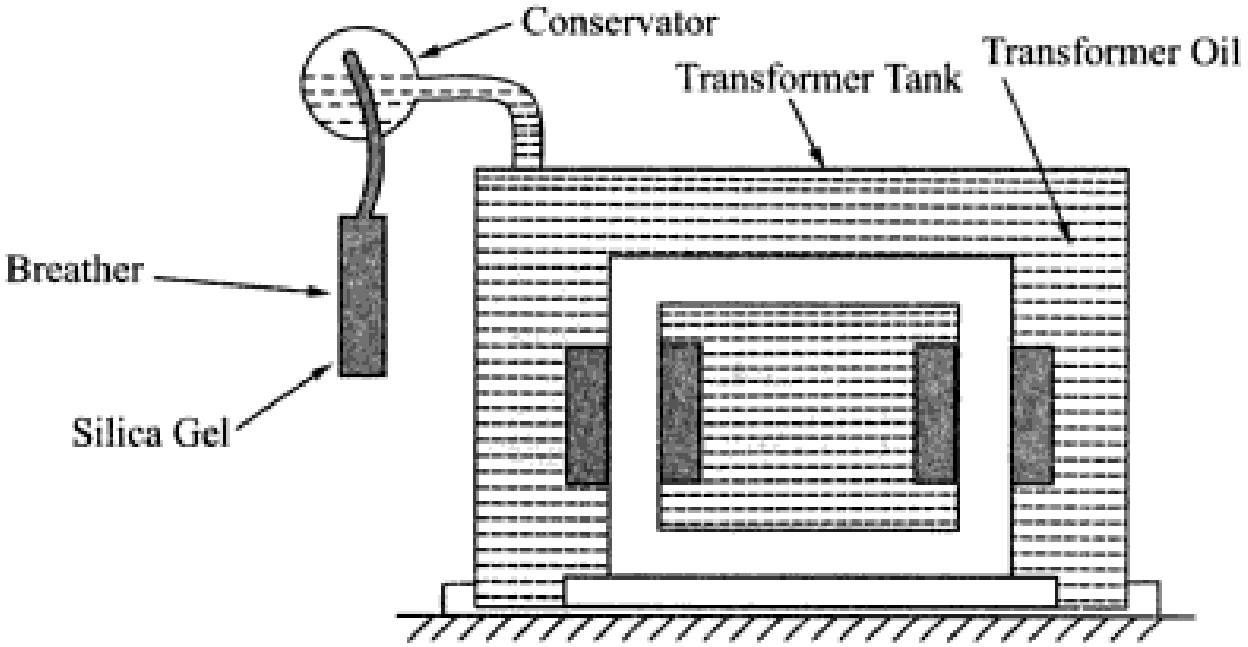
Transformer oil
The transformer oil insulates as well as cools the core and coil assembly. The core and windings of the transformer must be completely immersed in the oil that normally contains hydrocarbon mineral oils.

Small transformers are air cooled whereas large transformers are provided with oil or oil & air cooling
The transformer tank is designed to withstand full vacuum.

Conservator
The conservator is an airtight metallic cylindrical drum fitted above the transformer that conserves the transformer oil. It is vented at the top and is filled only half with the oil to allow expansion and contraction during temperature variations. However the main tank of the transformer with which the conservator is connected is completely filled with the oil through a pipeline.

Breather

The breather is a cylindrical container filled with silica gel, which is used to keep the air that enters the tank moisture-free. This is because the insulating oil when reacts with moisture can affect the insulation and cause internal faults, which is why it is a must to keep the air free from moisture. In the breather, when the air passes through the silica gel, the moisture contents are absorbed by the silica crystals.



•**Buchholz Relay** : Placed over the connecting pipe that runs from the main tank to conservator tank the Buchholz Relay senses the faults occurring within the transformer. It operates by the gases emitted due to decomposition of transformer oil during internal faults. Thus, this device is used to sense and in turn protect the transformer from internal faults.

•**Pressure Relief Device**: This is provided to relieve the internal pressure in the event of major fault within the transformer.

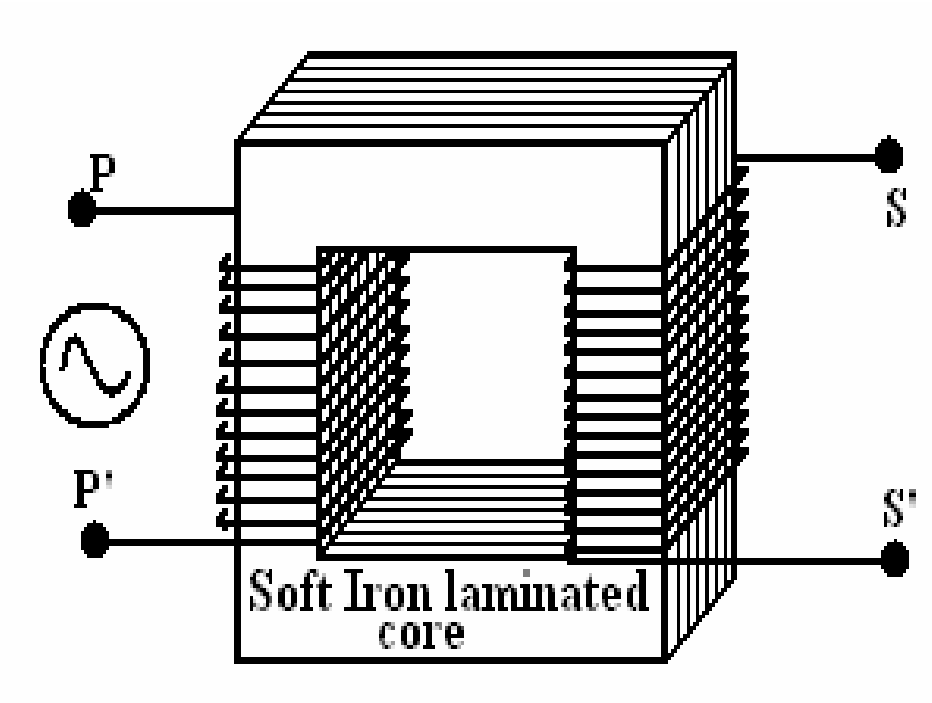
•**Tapping Switch**: To maintain secondary voltages reasonably constant at load end when incoming voltage and/or load on transformer changes, it is necessary to change the voltage ratio (I.e, turns ratio of the winding) of the transformer.

This is achieved by changing the number of turns (HT Side) by operating a switch called as tapping switch.

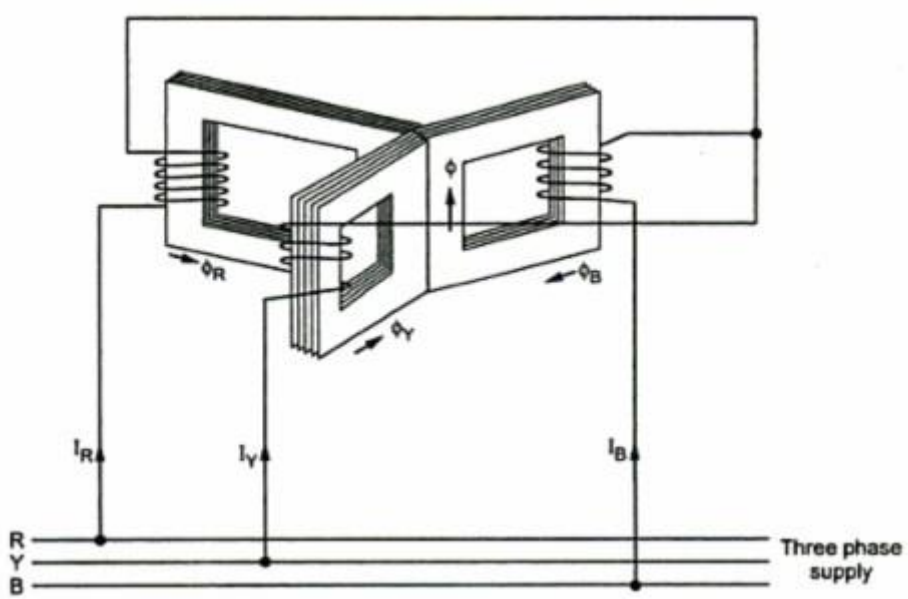
Depending on the requirement, **off circuit or on load tap changer** is installed in the transformer.

Working

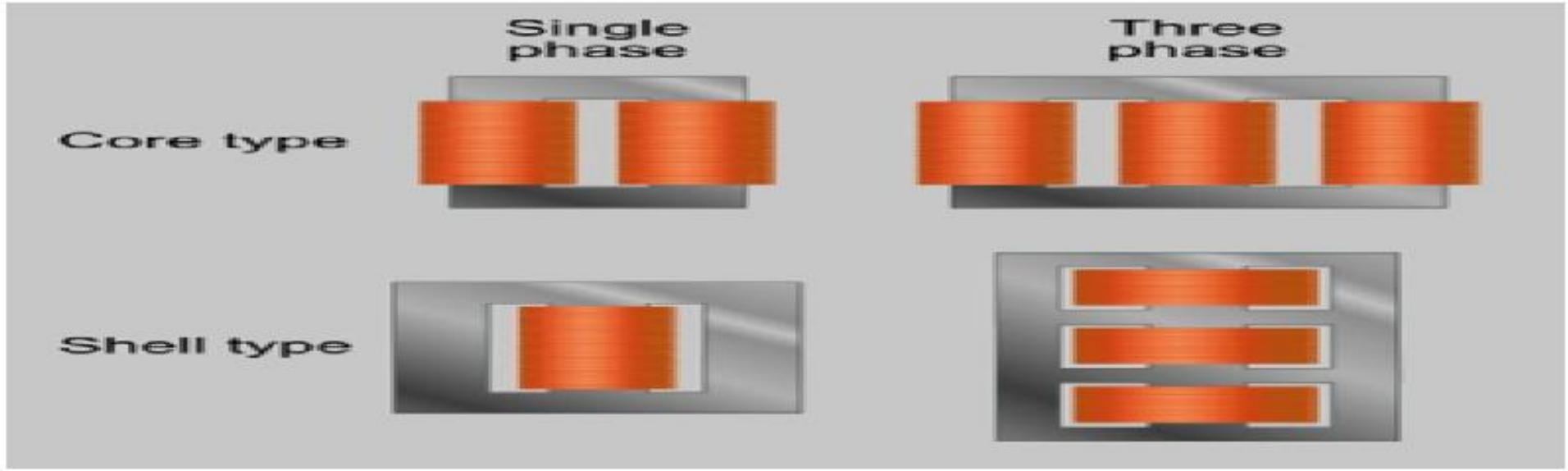
1. When current in the primary coil changes being alternating in nature, a changing magnetic field is produced
2. This changing magnetic field gets associated with the secondary through the soft iron core
3. Hence magnetic flux linked with the secondary coil changes.
4. Which induces e.m.f. in the secondary.

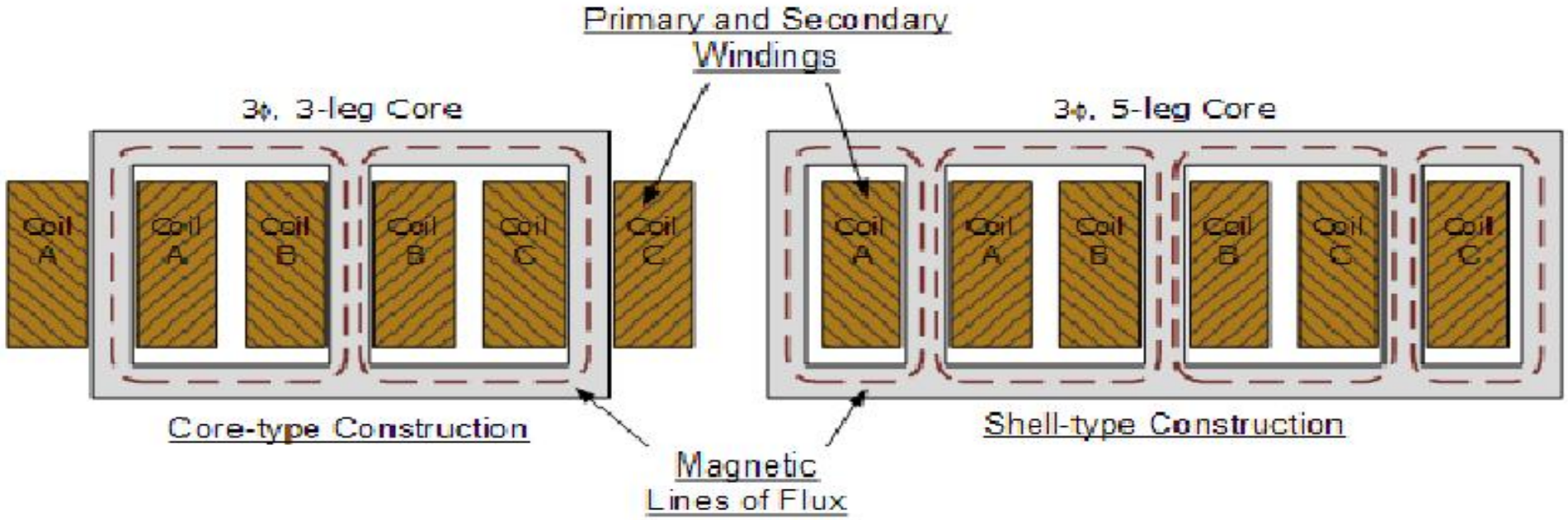


Three phase transformer



A three-phase transformer consists of three primary coils and three secondary coils and is represented as 3-phase or 3ϕ. A three-phase system can be constructed using three individual identical single-phase transformers, and such a 3-phase transformer is known as the bank of three transformers. On the other hand, the three-phase transformer can be built on a single core. The windings of a transformer can be connected in either delta or wye configurations. The working of the 3-phase system is similar to a single-phase transformer, and they are normally employed in power generation plants.


Single phase
Three phase
Core type
Shell type


Primary and Secondary Windings
3ϕ, 3-leg Core
3ϕ, 5-leg Core
Coil A
Coil A
Coil B
Coil B
Coil C
Coil C
Coil A
Coil A
Coil B
Coil B
Coil C
Coil C
Core-type Construction
Shell-type Construction
Magnetic Lines of Flux