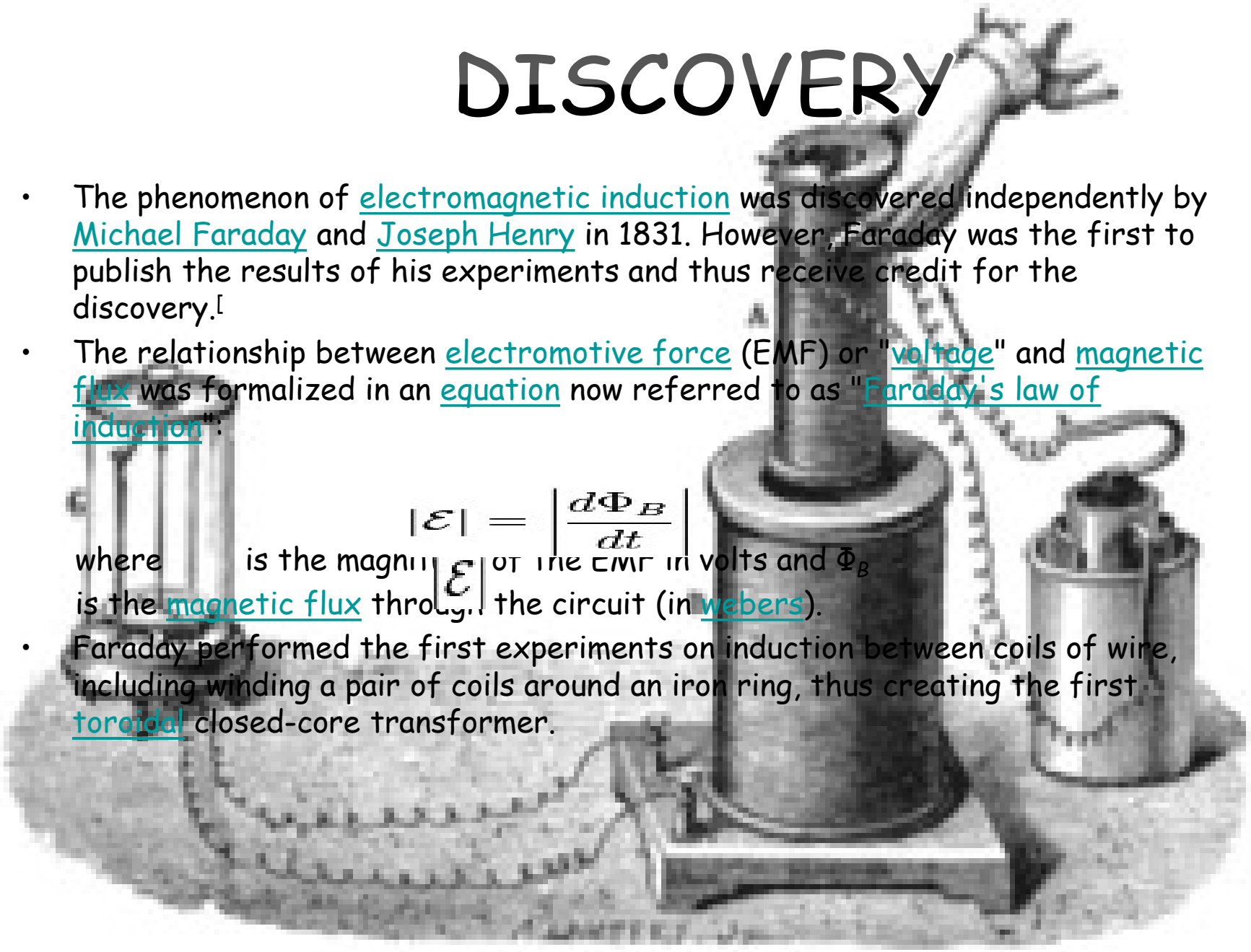

TRANSFORMER

INTRODUCTION

- A transformer is a device used for converting low alternating voltage at high current into high voltage at low current and vice-versa.
- It works on the principle of mutual induction i.e. if two coils are inductively coupled and when current or magnetic flux is changed through one of the two coils,then induced e.m.f is produced in the other coil.
- In the vast majority of transformers, the windings are coils wound around a ferromagnetic core, air-core transformers being a notable exception.
- Transformers range in size from a thumbnail-sized coupling transformer hidden inside a stage microphone to huge units weighing hundreds of tons used to interconnect portions of power grids.
- Transformers are essential for high voltage power transmission, which makes long distance transmission economically practical.

DISCOVERY



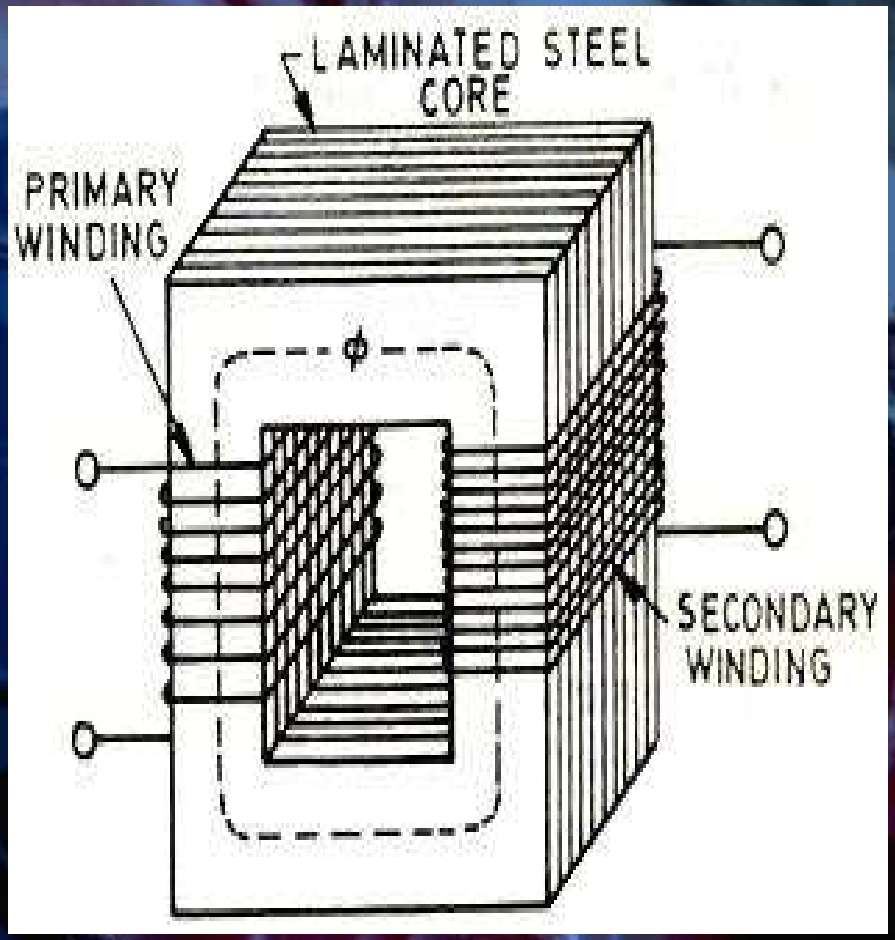
- The phenomenon of electromagnetic induction was discovered independently by Michael Faraday and Joseph Henry in 1831. However, Faraday was the first to publish the results of his experiments and thus receive credit for the discovery.[
- The relationship between electromotive force (EMF) or "voltage" and magnetic flux was formalized in an equation now referred to as "Faraday's law of induction":

$$|\mathcal{E}| = \left|\frac{d\Phi_B}{dt}\right|$$

where $|\mathcal{E}|$ is the magnitude of the EMF in volts and Φ_B is the magnetic flux through the circuit (in webers).

- Faraday performed the first experiments on induction between coils of wire, including winding a pair of coils around an iron ring, thus creating the first toroidal closed-core transformer.

CONSTRUCTION

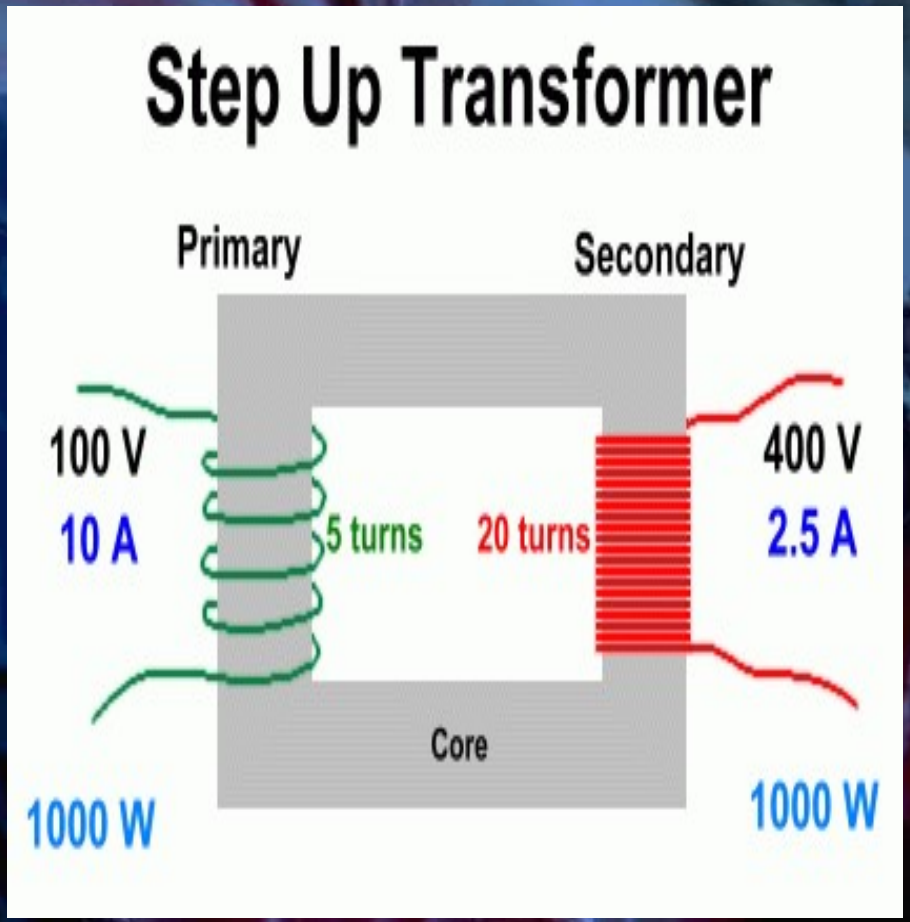


- An elementary transformer consists of a soft iron or silicon steel core and two windings, placed on it.
- The windings are insulated from both the core and each other. The core is built up of thin soft iron or low reluctance to the magnetic flux. The winding connected to the magnetic flux.
- The winding connected to the supply main is called the primary and the winding connected to the load circuit is called the secondary.

WORKING

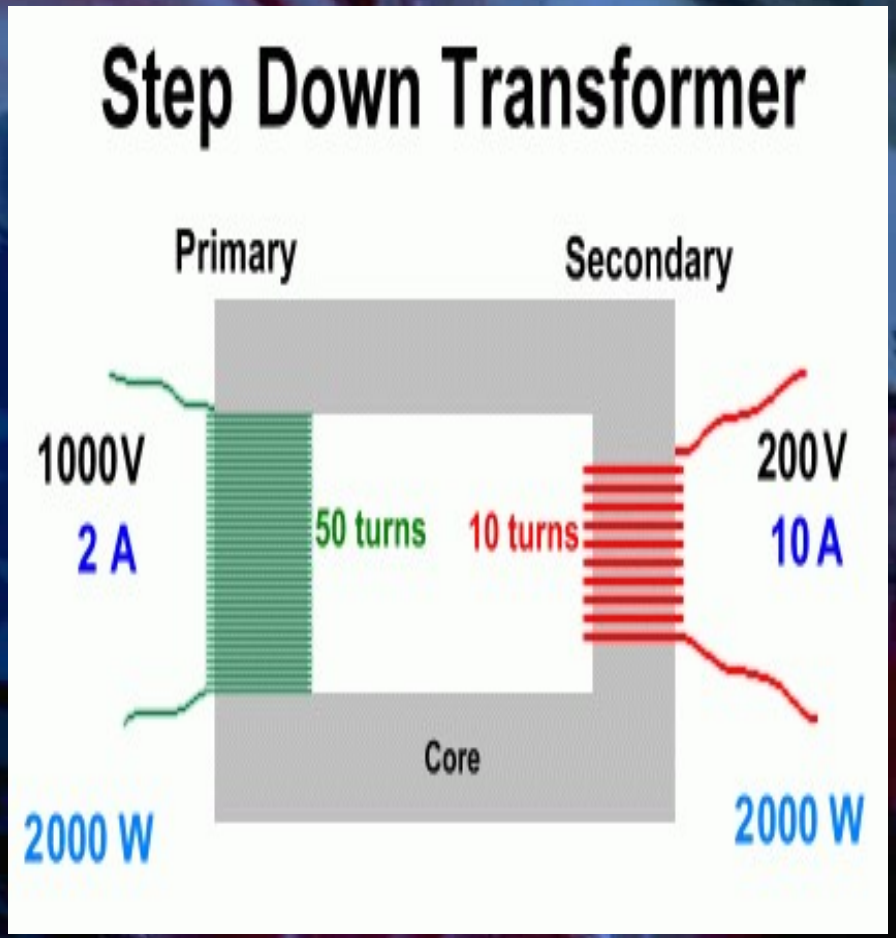
- When the primary winding is connected to an ac supply mains, current flows through it. Since this winding links with an iron core, so current flowing through this winding produces an alternating flux in the core. Since this flux is alternating and links with the secondary winding also, so induces an emf in the secondary winding.
- The frequency of induced emf in secondary winding is the same as that of the flux or that of the s supply voltage. The induced emf in the secondary winding enables it to deliver current to an external load connected across it. Thus the energy is transformed from primary winding to the secondary winding by means of electro-magnetic induction without any change in frequency.
- The flux Ø of the iron core links not only with the secondary winding but also with the primary winding, so produces self-induced emf in the primary winding: This induced in the primary winding opposes the applied voltage and therefore sometimes it is known as back emf of the primary. In fact the induced emf in the primary winding limits the primary current in much the same way that the back emf in a dc motor limits the armature current.

STEP-UP TRANSFORMER



- In a step up transformer,the number of turns in secondary coil (N_s) is greater than that of primary coil(N_p).
- The primary coil is made of a thick insulated copper wire ,while secondary coil of thin insulated wire.It converts low voltage at high current into high voltage at low current.

STEP-DOWN TRANSFORMER



- In a step-down transformer the number of turns in seondary coil (Ns) is less than that in primary coil(Np).
- In a step-down transformer ,the primary coil is made of a thin wire and the secondary coil of thick wire.It converts a high voltage at low current into a low voltage at high current

APPLICATIONS

- A step-down transformer is used for obtaining large current for electric welding.
- A step-down transformer is used in induction furnace for melting the metals.
- A step-up transformer is used for the production of X-rays.
- Transformers are used in voltage regulators and stabilised power supplies.

ENERGY LOSSES IN A TRANSFORMER

- Various types of energy losses,which occur in a transformer, are as follows-:

i. Flux losses:The coupling of primary and secondary coils is never perfect and whole of the magnetic flux produced in the primary coil never gets linked up with the secondary coil.

ii. Copper losses:Due to resistance of the windings of primary and secondary coils,some electrical energy is always converted into heat energy.

iii. Iron losses:The varying magnetic flux produces eddy currents in the iron core,which also leads to the wastage of energy in the form of heat.It is minimised using a laminated iron core.

iv. Hysteresis losses:The a.c. current flowing through the coils magnetises and demagnetises the iron core again and again.Due to which,some energy is lost because of hysteresis.However it can be minimised by selecting the material of core which has a narrow hysteresis loop.

ROLE OF TRANSFORMER IN ELECTRICITY TRANSMISSION

- Most of the electricity used at homes and businesses is generated at power plants; usually these power plants are located far away from metropolitan areas. Thus it becomes necessary to transmit electricity from remote locations to the cities; the traveling of electricity through long distances results in power losses.
- An effective solution to reduce the power losses along the way is electricity transmission at high voltages. For this purpose, the output voltage of the electric generating plants is increased using a step-up transformer. Subsequently, during transmission, the voltage is stepped-down in sub-stations and distributed to lines along city streets. Finally, transformers at street poles, step-down the voltage to 240 or 120 volts at which home appliances work.