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ELECTRICAL ENGINEERING DESIGN AND DRAWING – II

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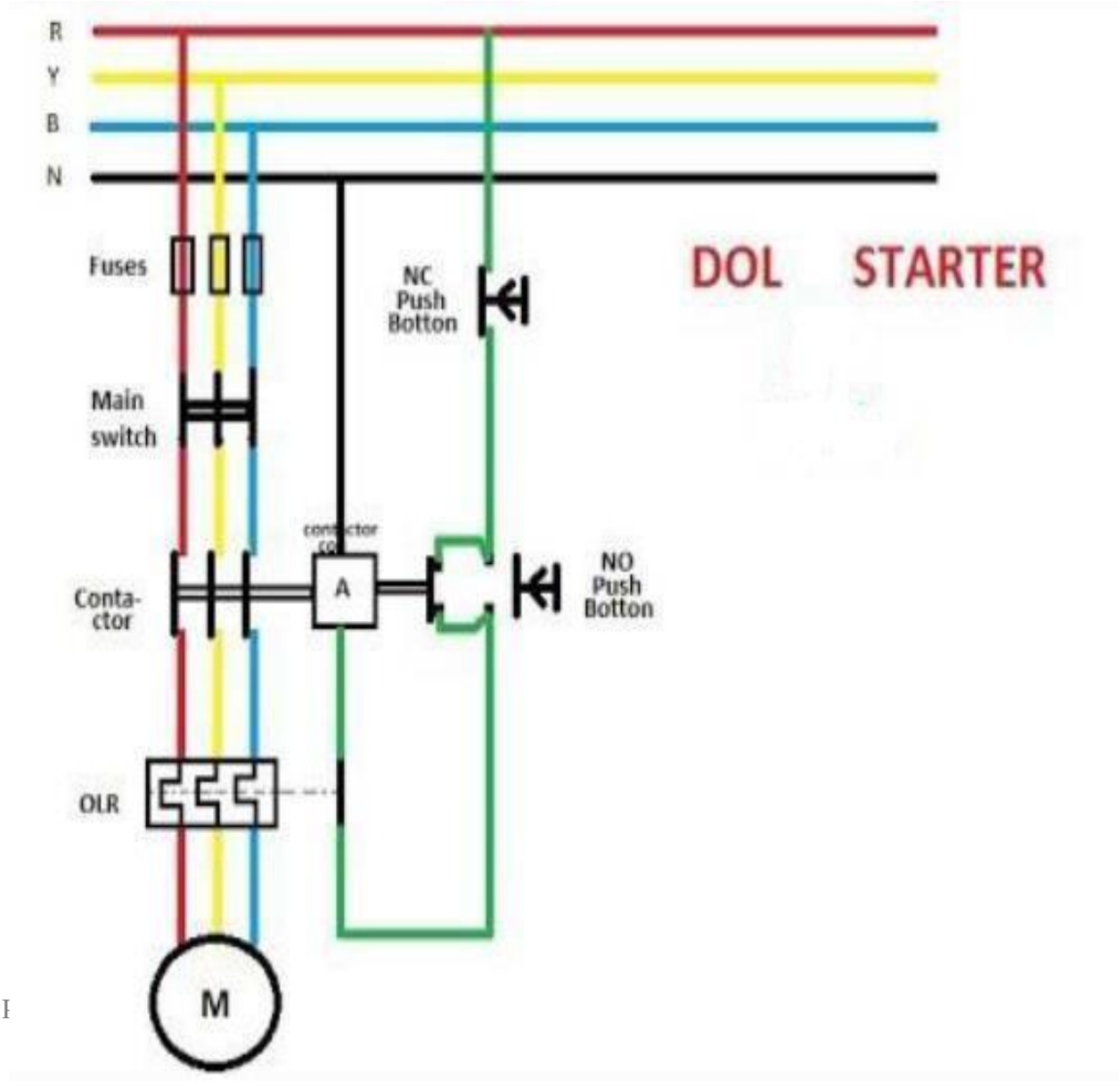
Contractor Control Circuits

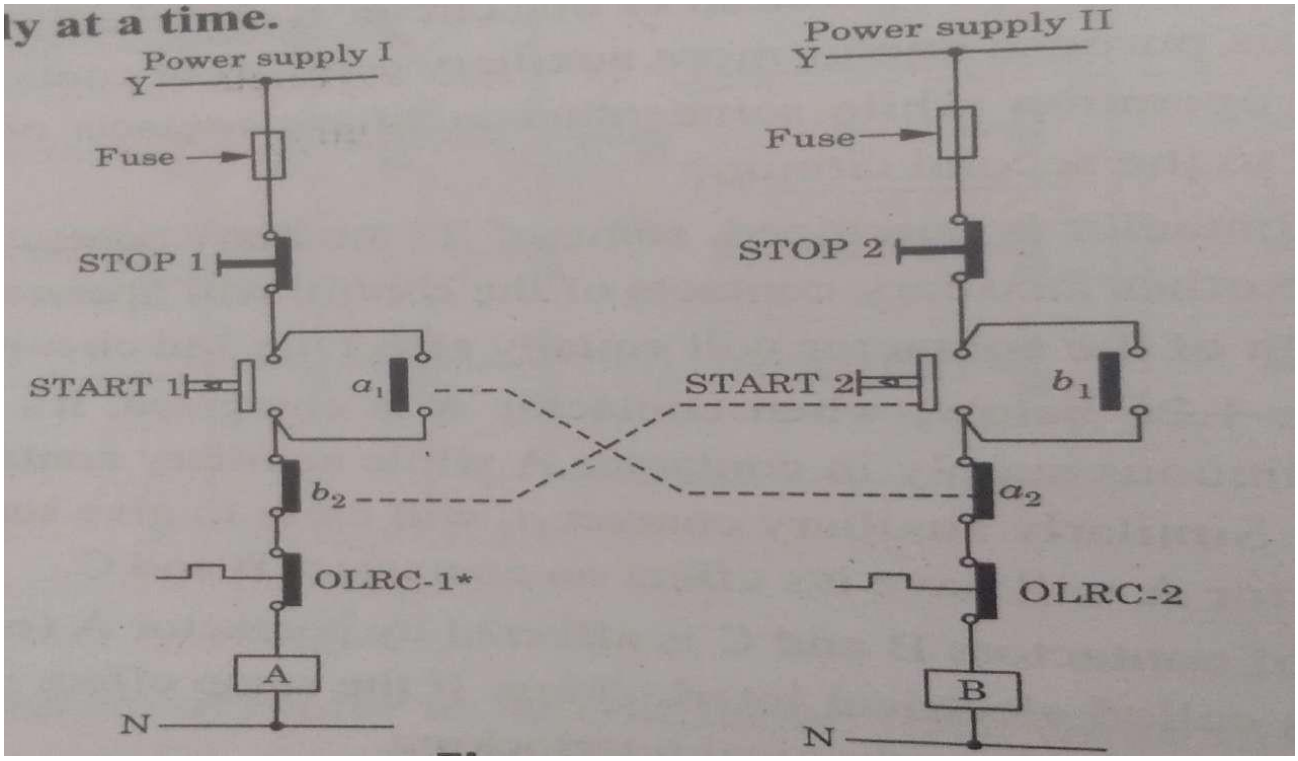
Contactor

- A contactor is an electrically controlled switch (relay) used for switching an electrical power circuit. A contactor is typically controlled by a circuit which has a much lower power level than the switched circuit, such as a 24-volt coil electromagnet controlling a 230-volt motor switch.
- Contactors are used to control electric motors, lighting, heating, capacitor banks, thermal evaporators, and other electrical loads.
- A contactor has three components. The *contacts* are the current carrying part of the contactor. This includes power contacts, auxiliary contacts, and contact springs**.**

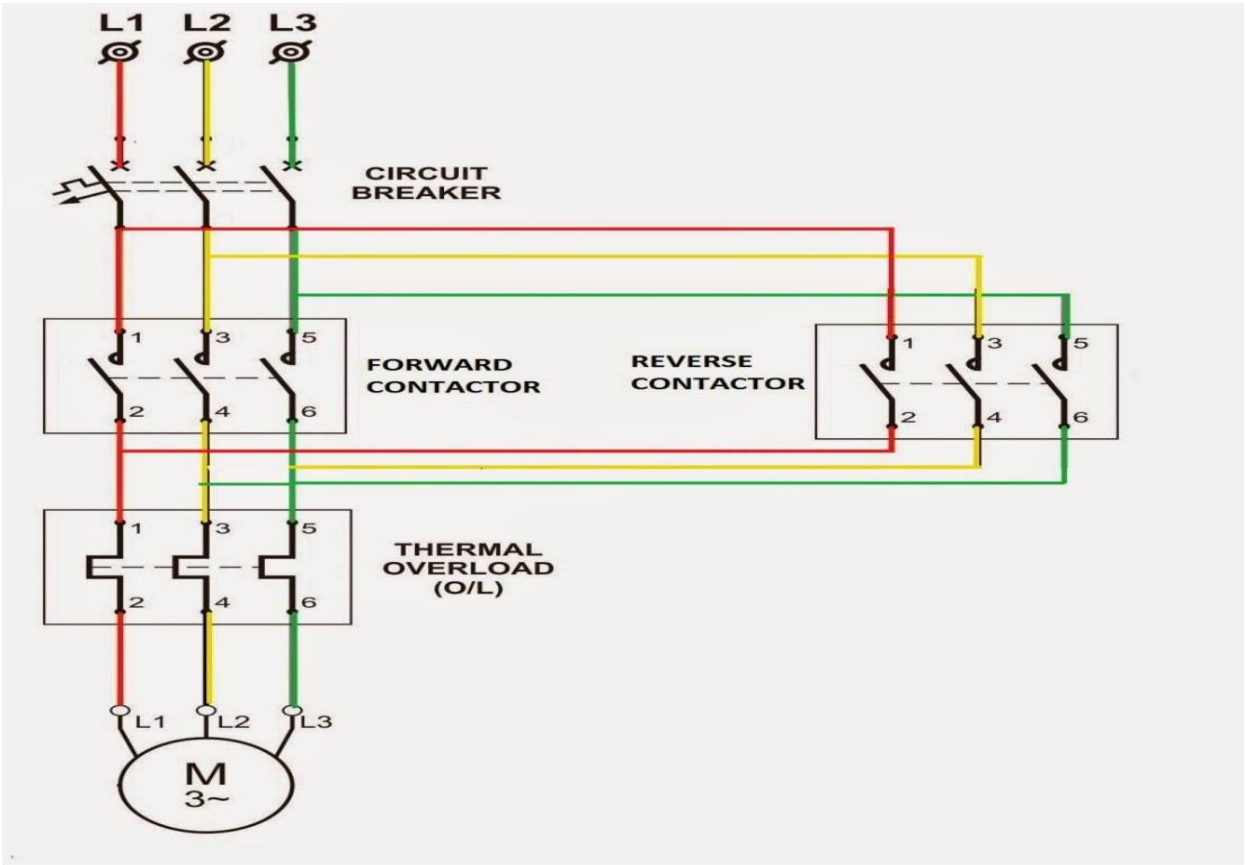
1.1 DOL starting of 3-phase induction motor



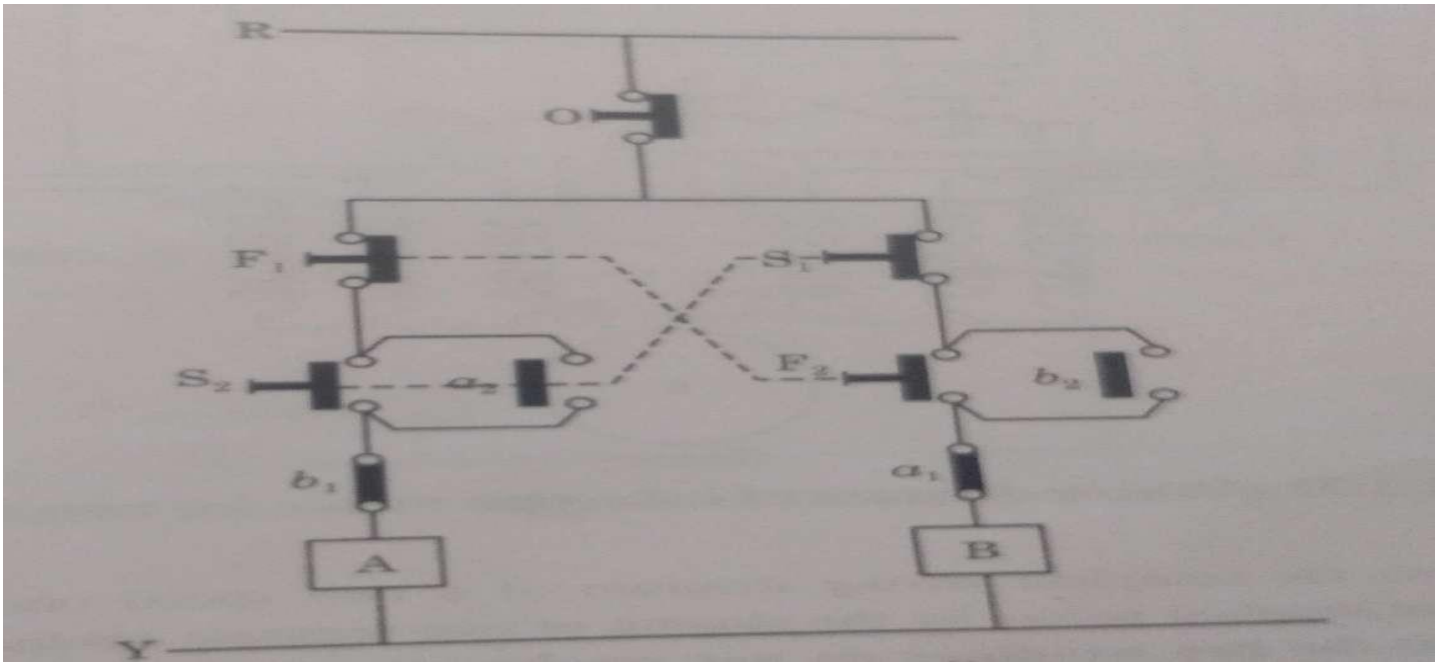
1.2 3- phase I.M. getting supply from selected feeder



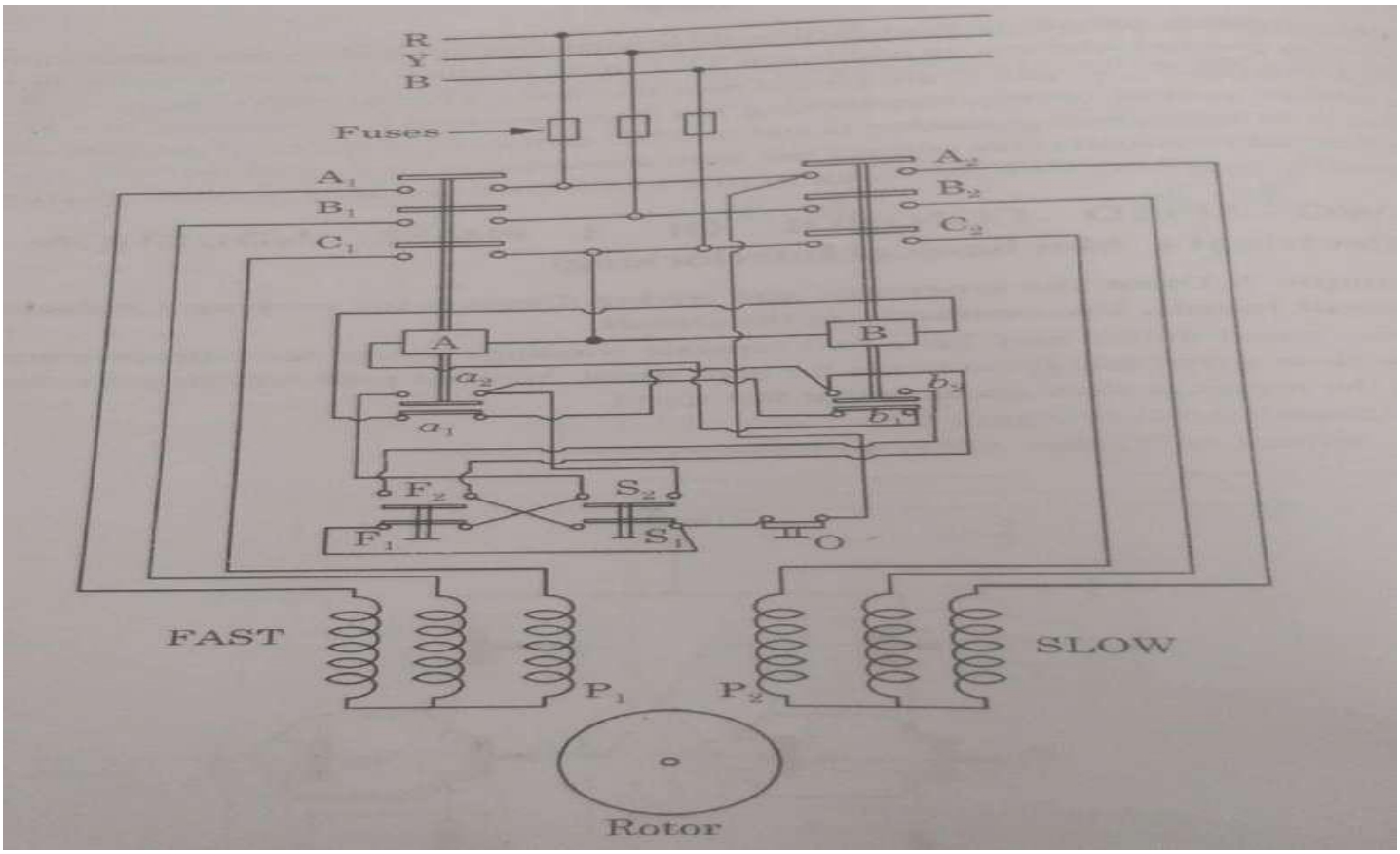
1.3 Forwarding/reversing of a 3-phase induction motor



1.4 Two speed control of 3- phase Induction motor (Schematic Diagram)



1.4 Two speed control of 3- phase Induction motor (Wiring Diagram)



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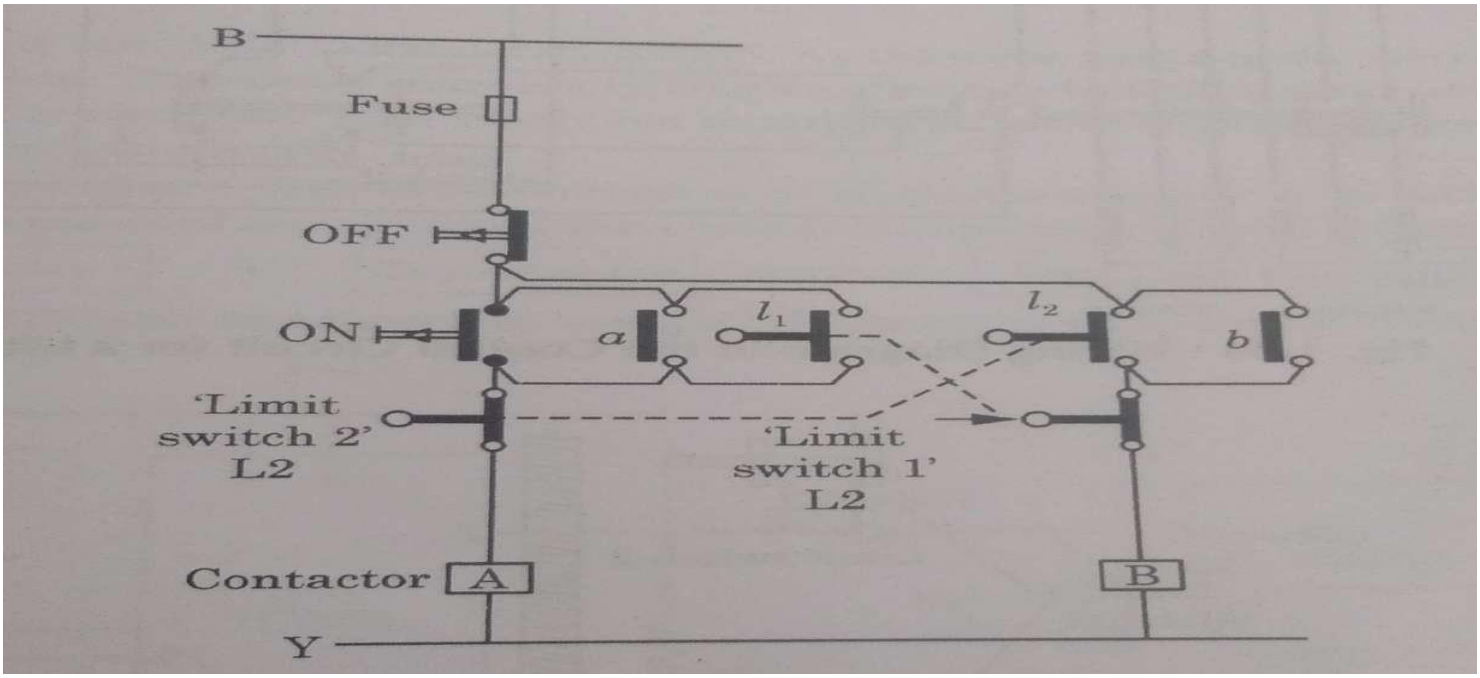
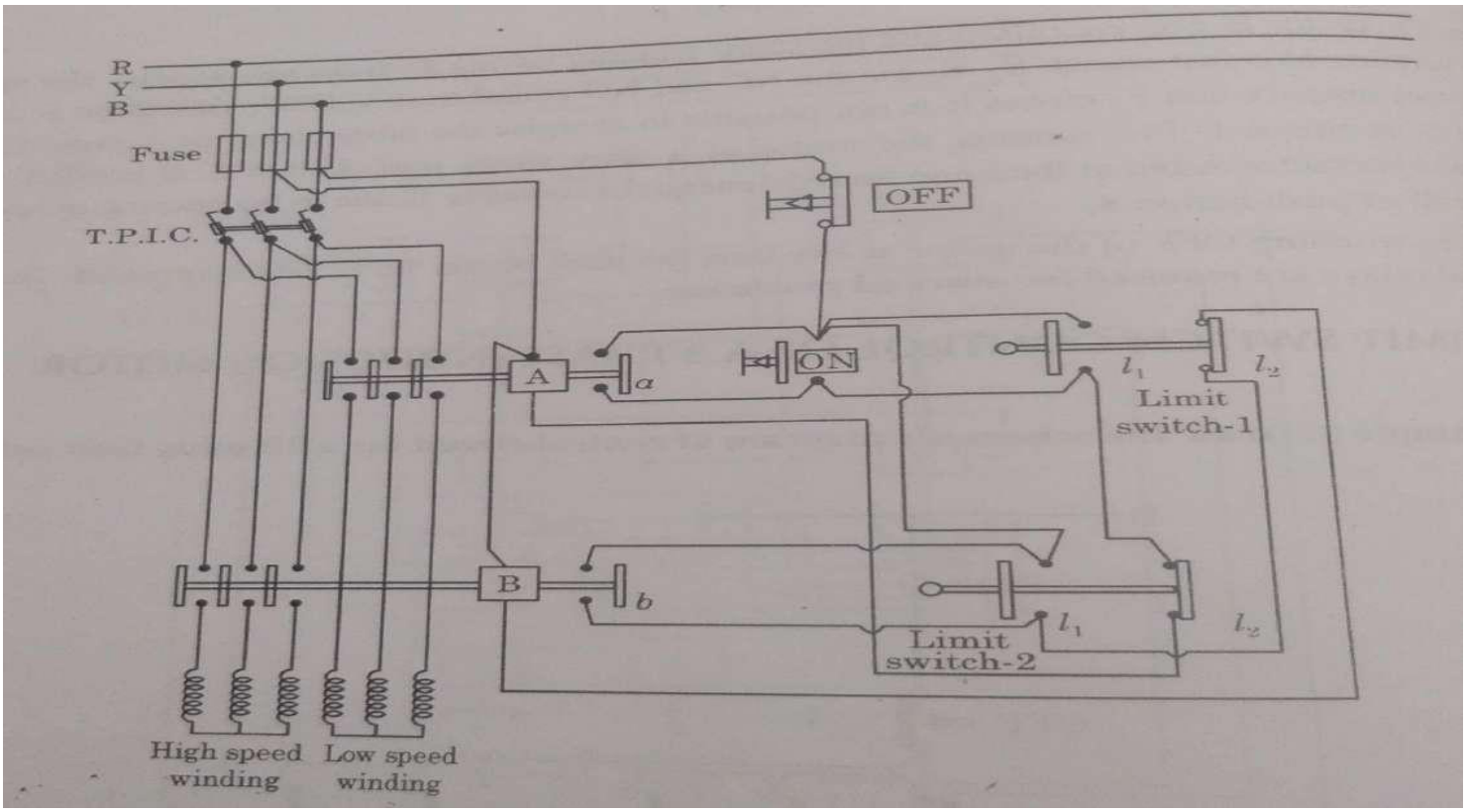
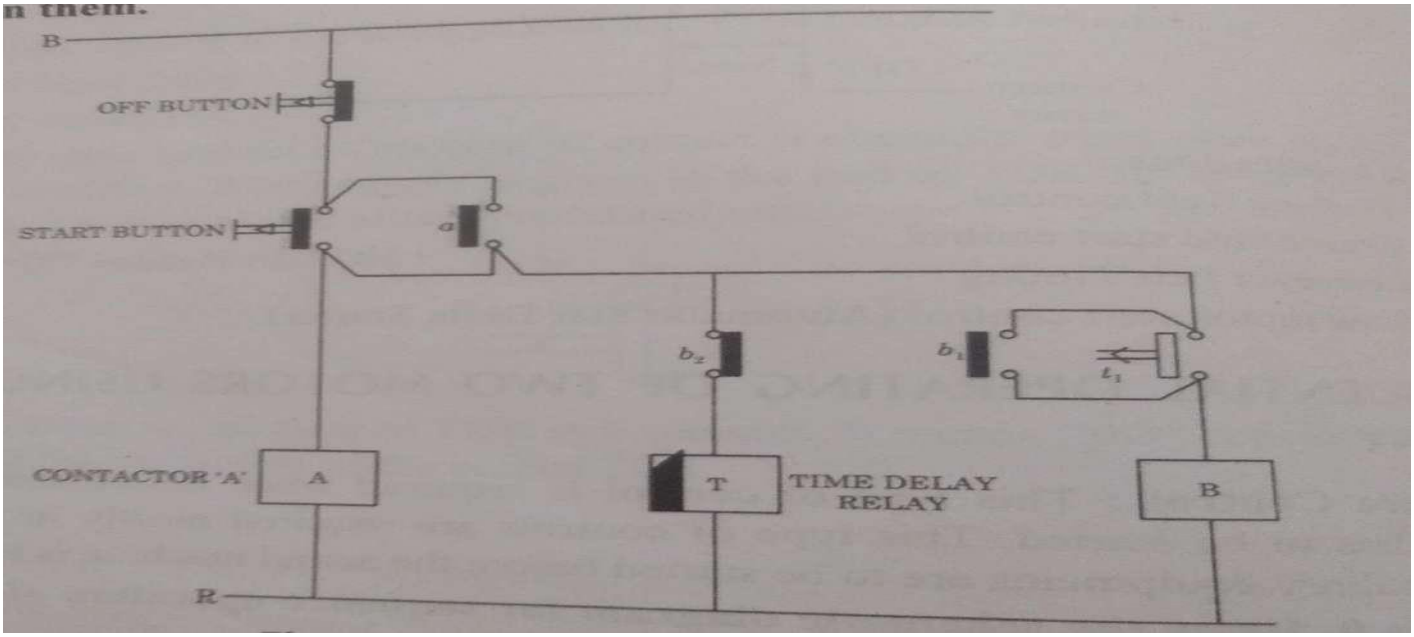
1.5 Limit switch control of a 3-phase Induction motor (Schematic Diagram)



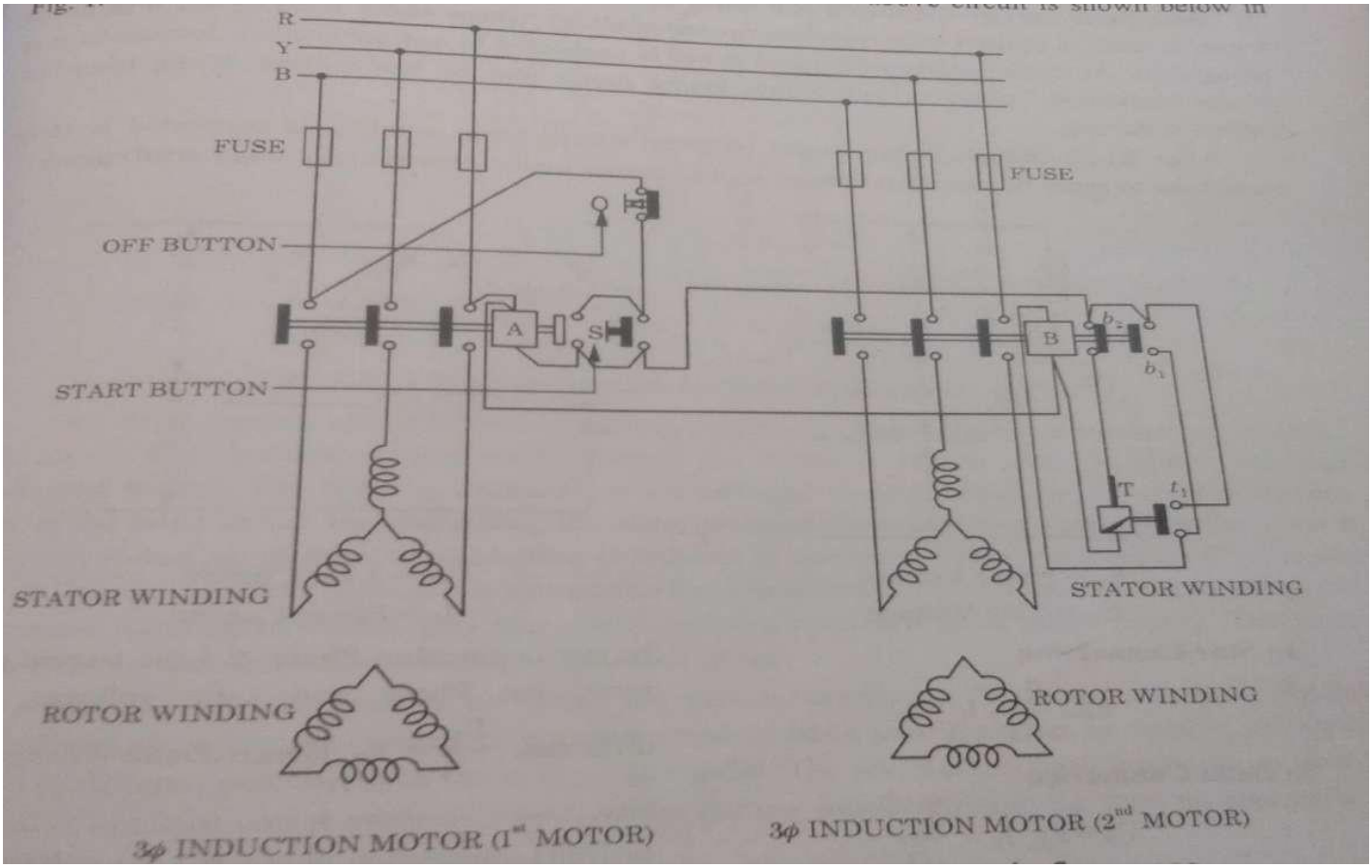
1.5 Limit switch control of a 3-phase Induction motor (Wiring Diagram)



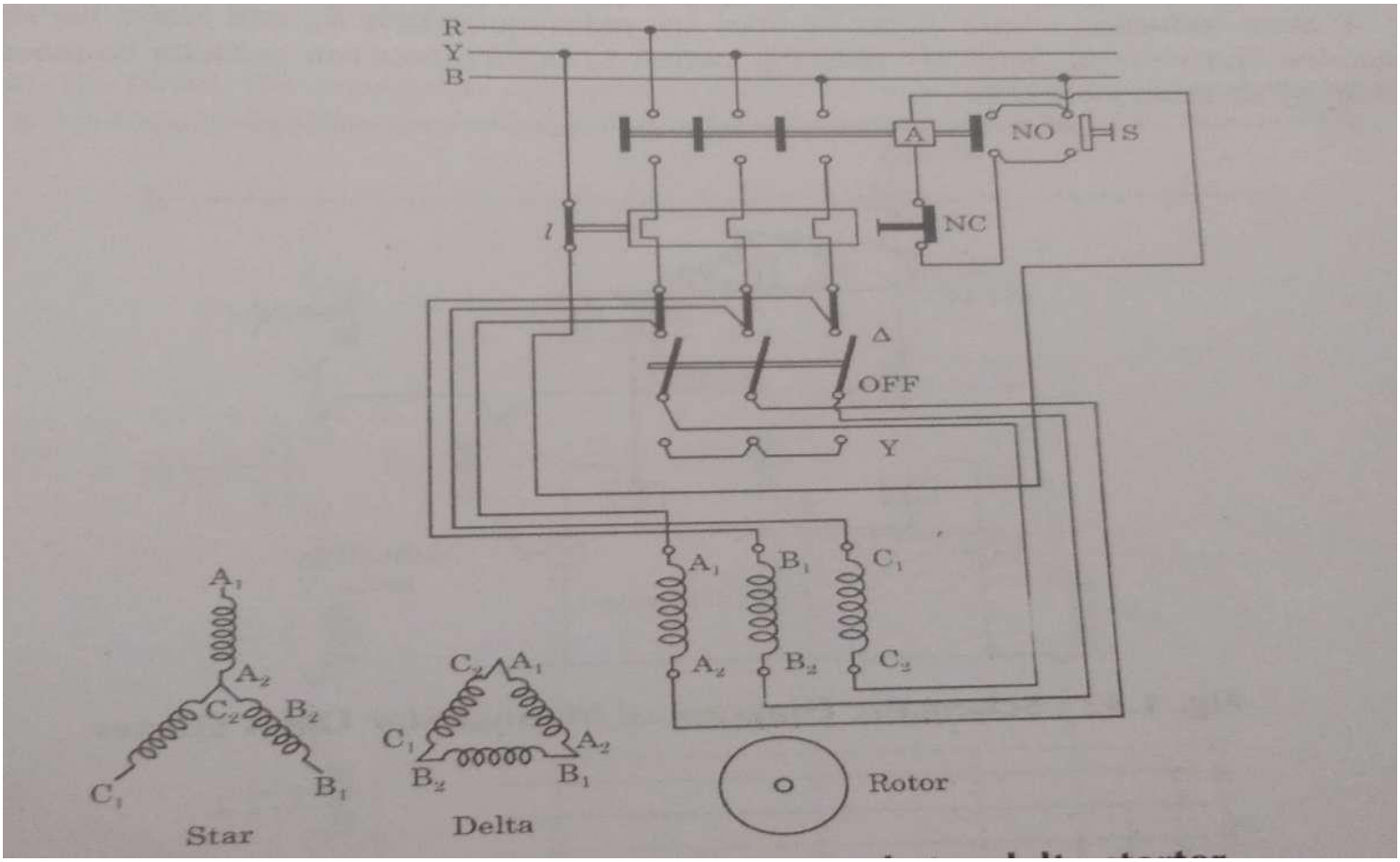
1.6 Sequential Operation of Two Motors using TDR (Schematic Diagram)



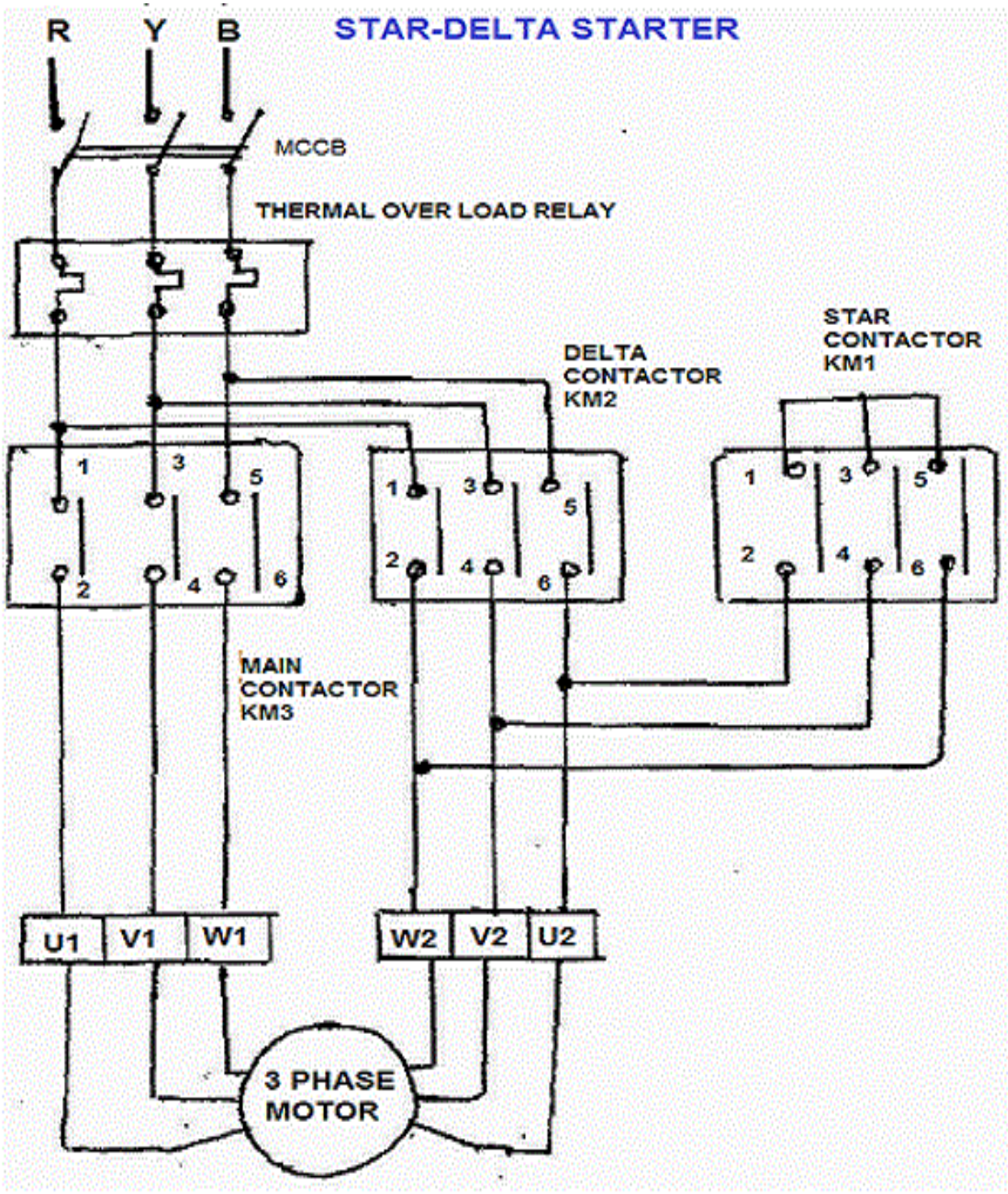
1.6 Sequential Operation of Two Motors using TDR (Wiring Diagram)



1.7 Manual Star Delta Starter for 3 phase Induction Motor



1.8 Star delta starter for 3-phase Induction Motor



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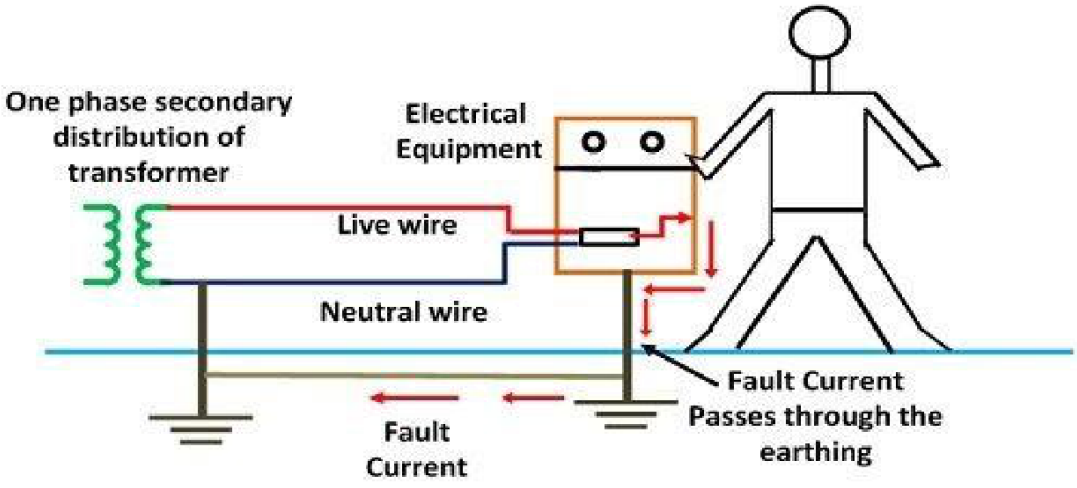
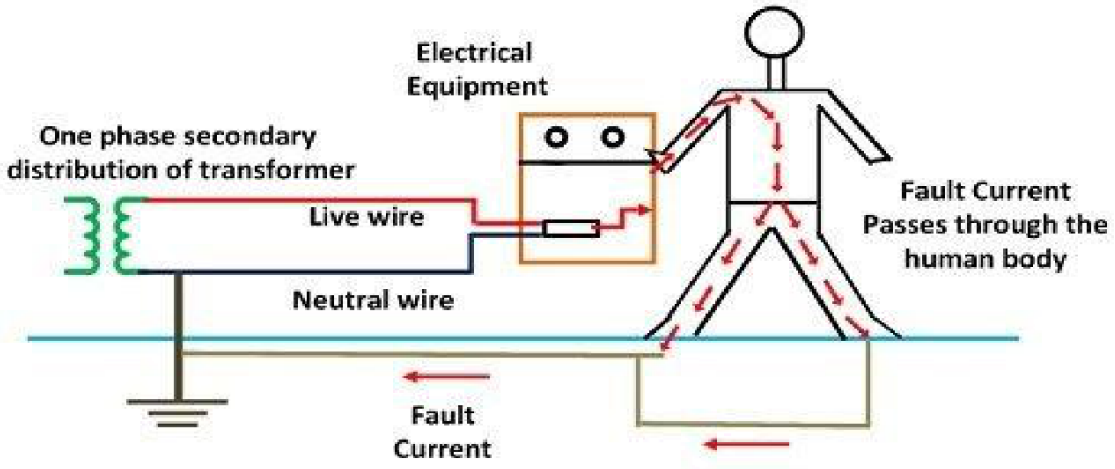
Electrical Earthing

- Definition: The process of transferring the immediate discharge of the electrical energy directly to the earth by the help of the low resistance wire is known as the electrical earthing.
- The electrical earthing is done by connecting the non-current carrying part of the equipment or neutral of supply system to the ground.
- To protect human lives as well as provide safety to electrical devices and appliances from leakage current we use earthing.
- To avoid the risk of fire in electrical installation systems



Electrical System With Earthing



Electrical System Without Earthing

Importance

- The earthing is essential because of the following reasons
- The earthing protects the personnel from the short circuit current.
- The earthing provides the easiest path to the flow of short circuit current even after the failure of the insulation.
- The earthing protects the apparatus and personnel from the high voltage surges and lightning discharge.

Method of reducing earth resistance

- A process for reducing the earth resistance in the soil surrounding an earth electrode which comprises treating the soil surrounding by means of salt and charcoal so that moisture is maintained
- Puring water in earthing
- Area of earthing plate should be large

Types

- Pipe Earthing
- Plate Earthing

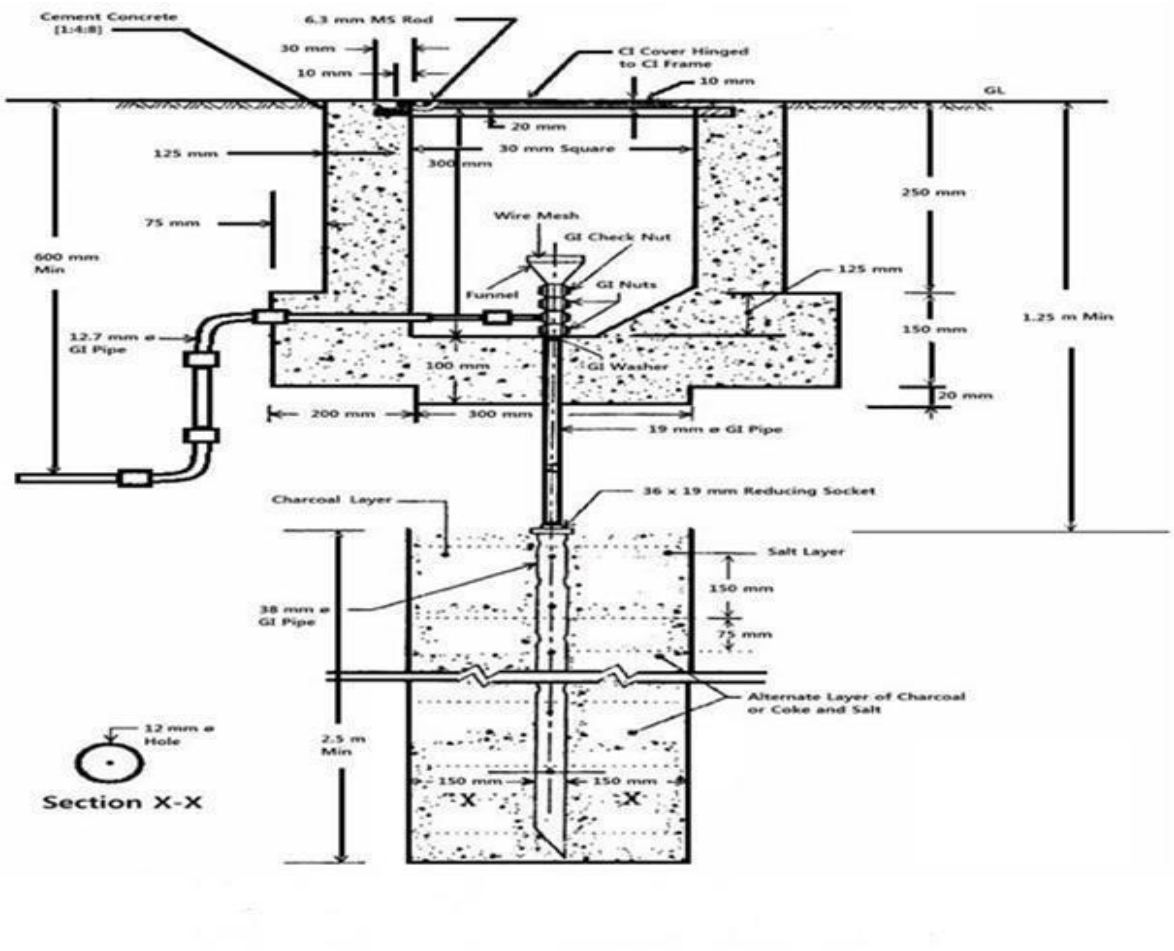


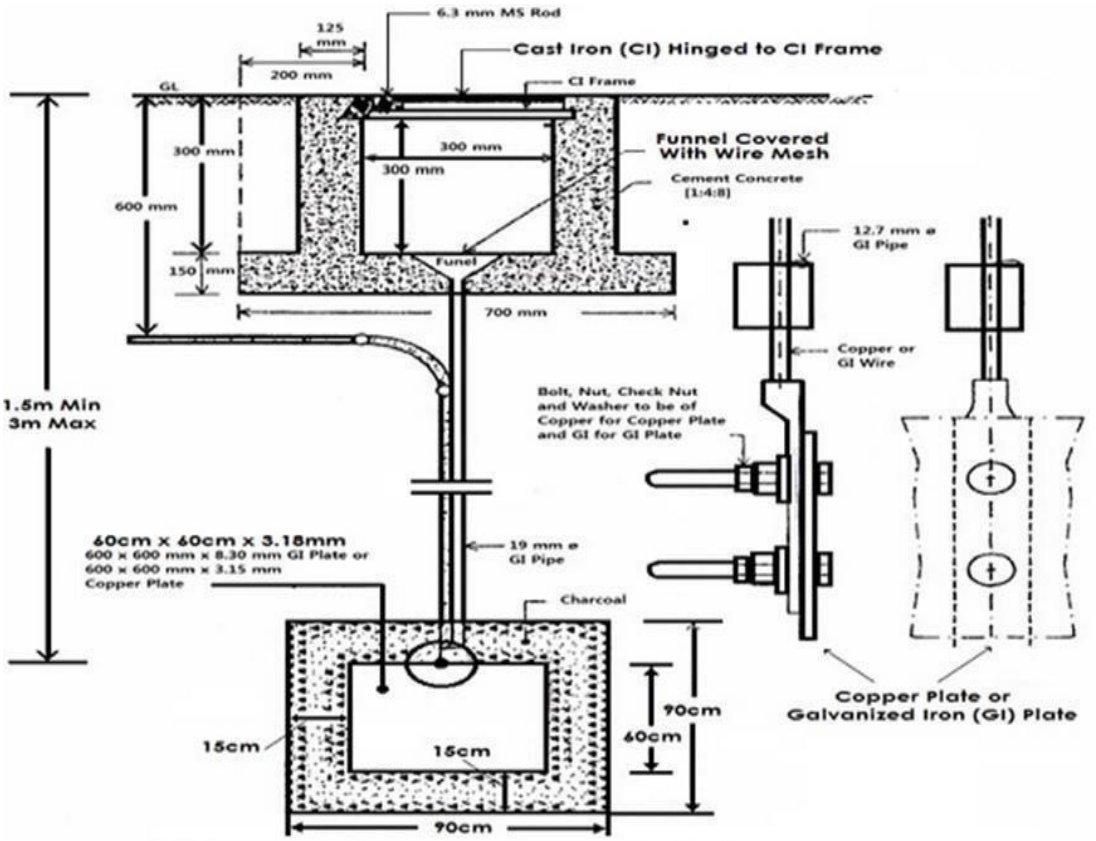
Fig. Pipe Earthing

Pipe Earthing:

- A galvanized steel and a perforated pipe of approved length and diameter is placed vertically in a wet soil in this kind of system of earthing. It is the most common system of earthing.
- The size of pipe to use depends on the magnitude of current and the type of soil. The dimension of the pipe is usually 40mm (1.5in) in diameter and 2.75m (9ft) in length for ordinary soil or greater for dry and rocky soil.
- The moisture of the soil will determine the length of the pipe to be buried but usually it should be 4.75m (15.5ft).

Plate Earthing:

- In plate earthing system, a plate made up of either copper with dimensions 60cm x 60cm x 3.18mm (i.e. 2ft x 2ft x 1/8 in) or galvanized iron (GI) of dimensions 60cm x 60cm x 6.35 mm (2ft x 2ft x ¼ in) is buried vertical in the earth (earth pit) which should not be less than 3m (10ft) from the ground level.
- For proper earthing system, follow the above mentioned steps in the (Earth Plate introduction) to maintain the moisture condition around the earth electrode or earth plate.



Material Required for Earthing

•**Earth Electrode:**
Any strip, pipe, plate or rod embedded in the earth for earthing of electrical equipments is known as Earth Electrode.

•**Earthing Chamber Cover:**
It is generally used to cover & protect the earthing from undesirable accidents. Made of Supreme quality of Raw Materials.

•**Back Fill Compound:**
Empty space around electrode is filled with compound to maintain moisture & enhance conductivity around the electrode.

•**Salt:**
Pure & premium quality of salt is used to reduce resistivity of Soil.

•**Charcoal Dust:**
It is filled in the Earth pit to enhance conductivity of soil

Sub-Station

The assembly of apparatus used to change some characteristic (*e.g. voltage, a.c. to d.c., frequency,*
p.f. etc.) *of electric supply is called a* **sub-station.**

Sub-stations are important part of power system. The continuity of supply depends to a considerable extent upon the successful operation of sub-stations. It is, therefore, essential to exercise utmost care while designing and building a sub-station. The following are the important points which must be kept in view while laying out a sub-station :

(i) It should be located at a proper site. As far as possible, it should be located at the centre of gravity of load.

(ii) It should provide safe and reliable arrangement. For safety, consideration must be given to the maintenance of regulation clearances, facilities for carrying out repairs and maintenance, abnormal occurrences such as possibility of explosion or fire etc. For reliability, consideration must be given for good design and construction, the provision of suitable protective gear *etc.*

(iii) It should be easily operated and maintained.

(iv) It should involve minimum capital cost.

Classification of Sub-Stations

There are several ways of classifying sub-stations. However, the two most important ways of classifying them are according to (1) service requirement and (2) constructional features.

1. According to service requirement. A sub-station may be called upon to change voltage level or improve power factor or convert a.c. power into d.c. power etc. According to the service requirement, sub-stations may be classified into :

(i) Transformer sub-stations. Those sub-stations which change the voltage level of electric supply are called transformer sub-stations. These sub-stations receive power at some voltage and deliver it at some other voltage. Obviously, transformer will be the main component in such substations.

Most of the sub-stations in the power system are of this type.

(ii) Switching sub-stations. These sub-stations do not change the voltage level *i.e.* incoming and outgoing lines have the same voltage. However, they simply perform the switching operations of

power lines.

(iii) Power factor correction sub-stations. Those sub-stations which improve the power factor of the system are called power factor correction sub-stations. Such sub-stations are generally located
at the receiving end of transmission lines. These sub-stations generally use synchronous condensers
as the power factor improvement equipment.

(iv) Frequency changer sub-stations. Those sub-stations which change the supply frequency are known as frequency changer sub-stations. Such a frequency change may be required for industrial
utilisation.

(v) Converting sub-stations. Those sub-stations which change a.c. power into d.c. power are called converting sub-stations. These sub-stations receive a.c. power and convert it into d.c. power

According to constructional features. A sub-station has many components (*e.g.* circuit breakers, switches, fuses, instruments etc.) which must be housed properly to ensure continuous and
reliable service. According to constructional features, the sub-stations are classified as :
(*i*) Indoor sub-station **(*ii*)** Outdoor sub-station
(*iii*) Underground sub-station **(*iv*)** Pole-mounted sub-station

(i) Indoor sub-stations. For voltages upto 11 kV, the equipment of the sub-station is installed indoor because of economic considerations. However, when the atmosphere is contaminated with
impurities, these sub-stations can be erected for voltages upto 66 kV.

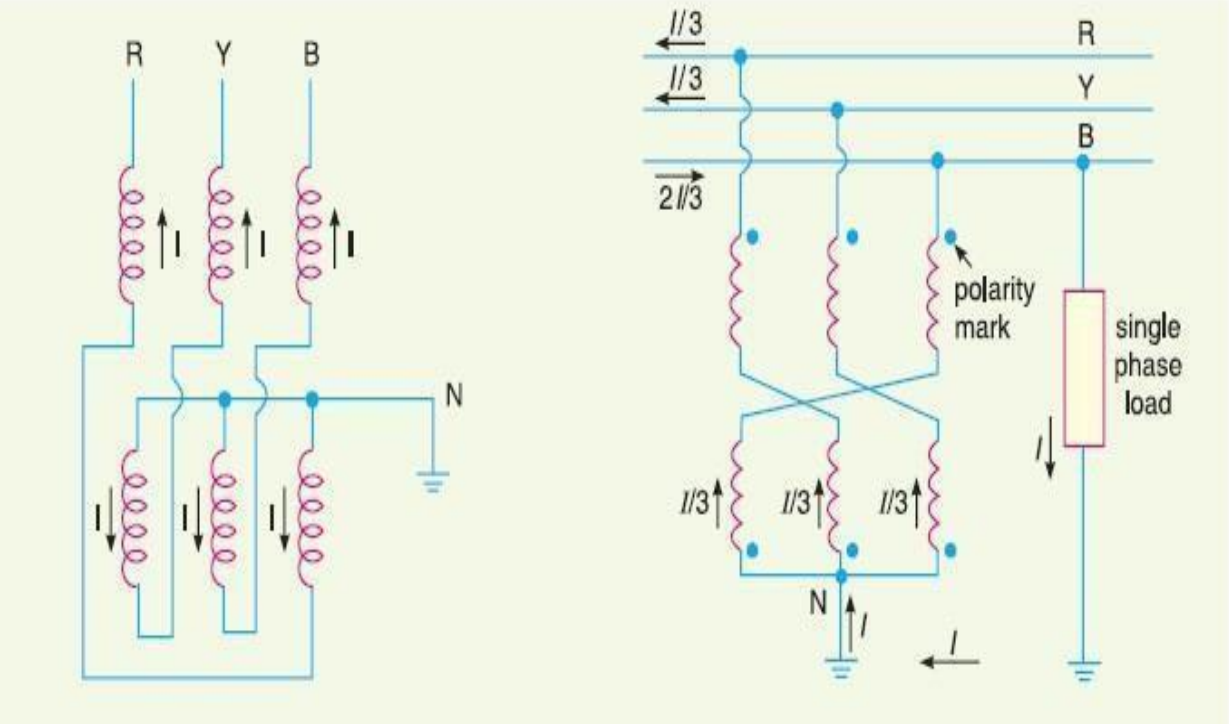
(ii) Outdoor sub-stations. For voltages beyond 66 kV, equipment is invariably installed outdoor.

It is because for such voltages, the clearances between conductors and the space required for switches, circuit breakers and other equipment becomes so great that it is not economical to install the equipment indoor.

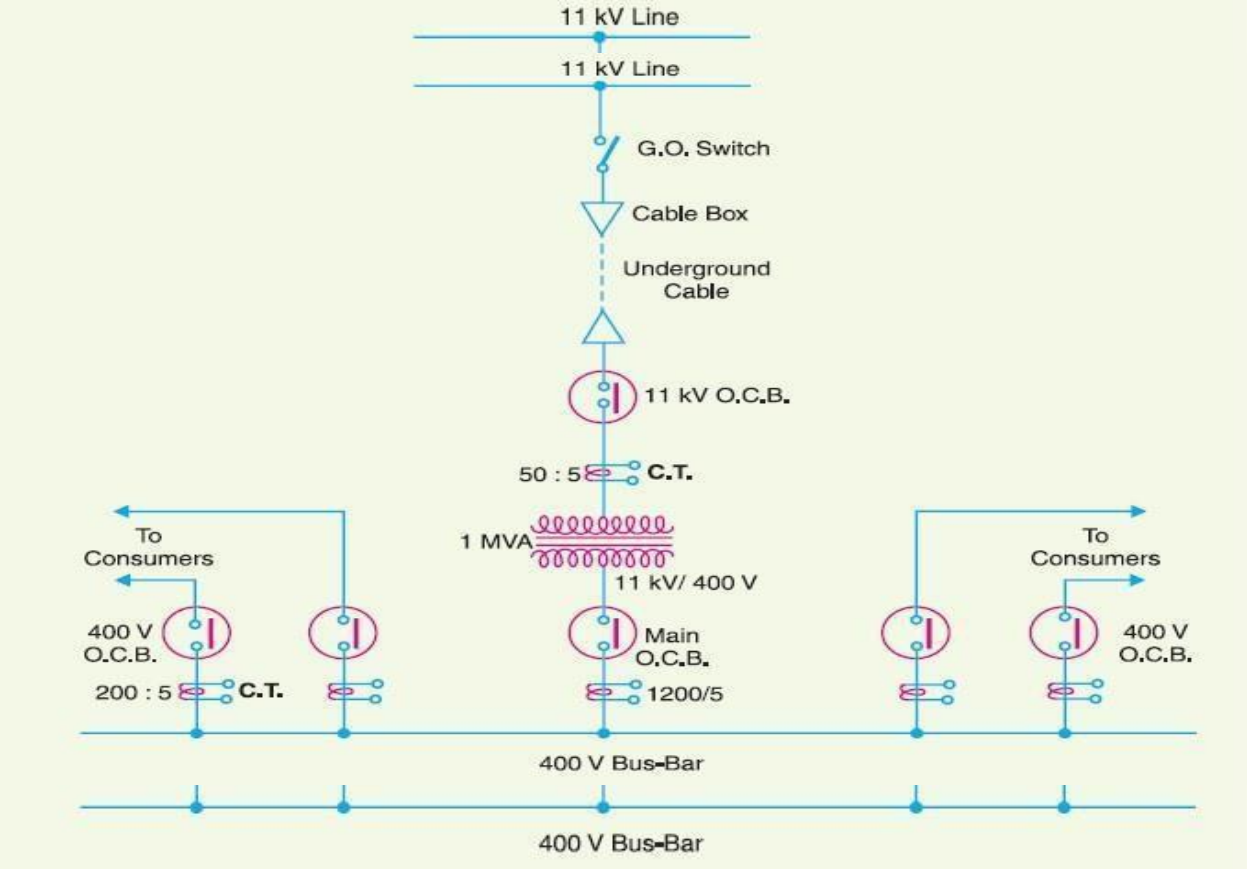
(iii) Underground sub-stations. In thickly populated areas, the space available for equipment and building is limited and the cost of land is high. Under such situations, the sub-station is createdunderground.

(iv) Pole-mounted sub-stations. This is an outdoor sub-station with equipment installed overhead on *H*-pole or 4-pole structure. It is the cheapest form of sub-station for voltages not exceeding 11kV (or 33 kV in some cases). Electric power is almost distributed in localities through such substations.

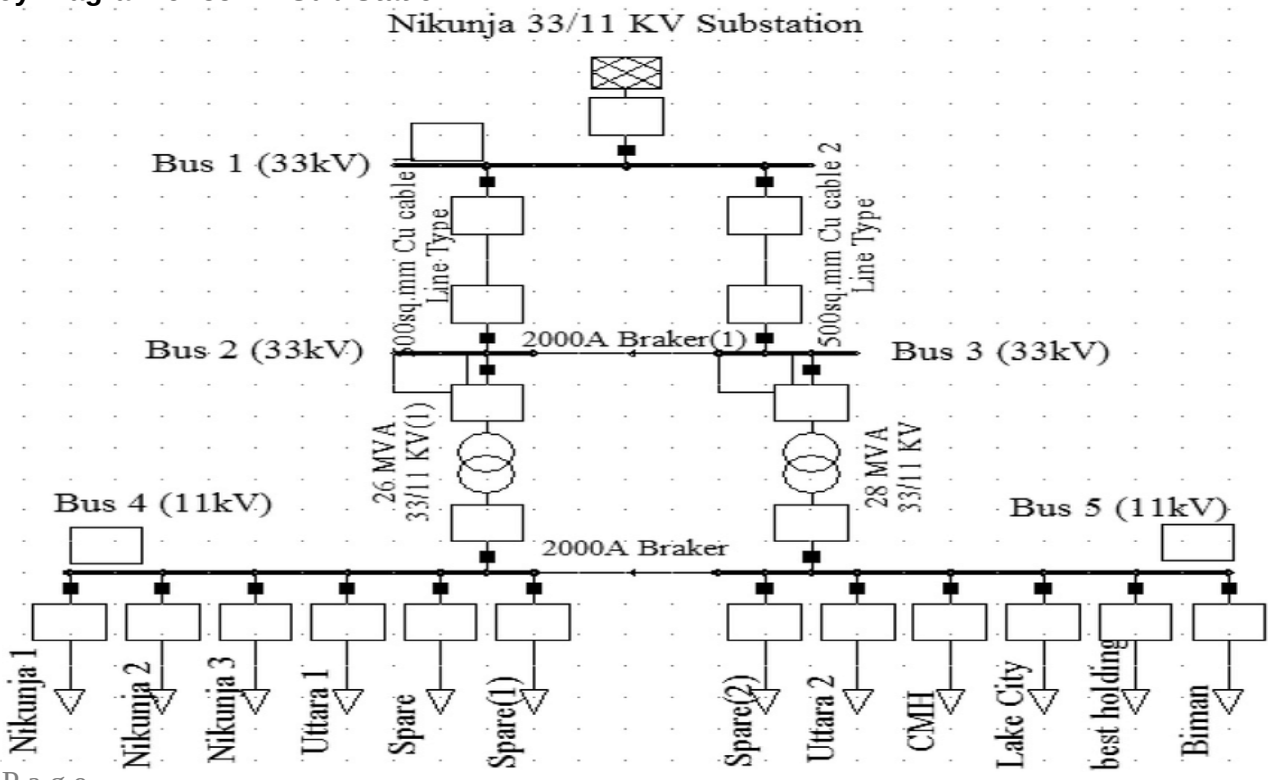
Transformer Grounding



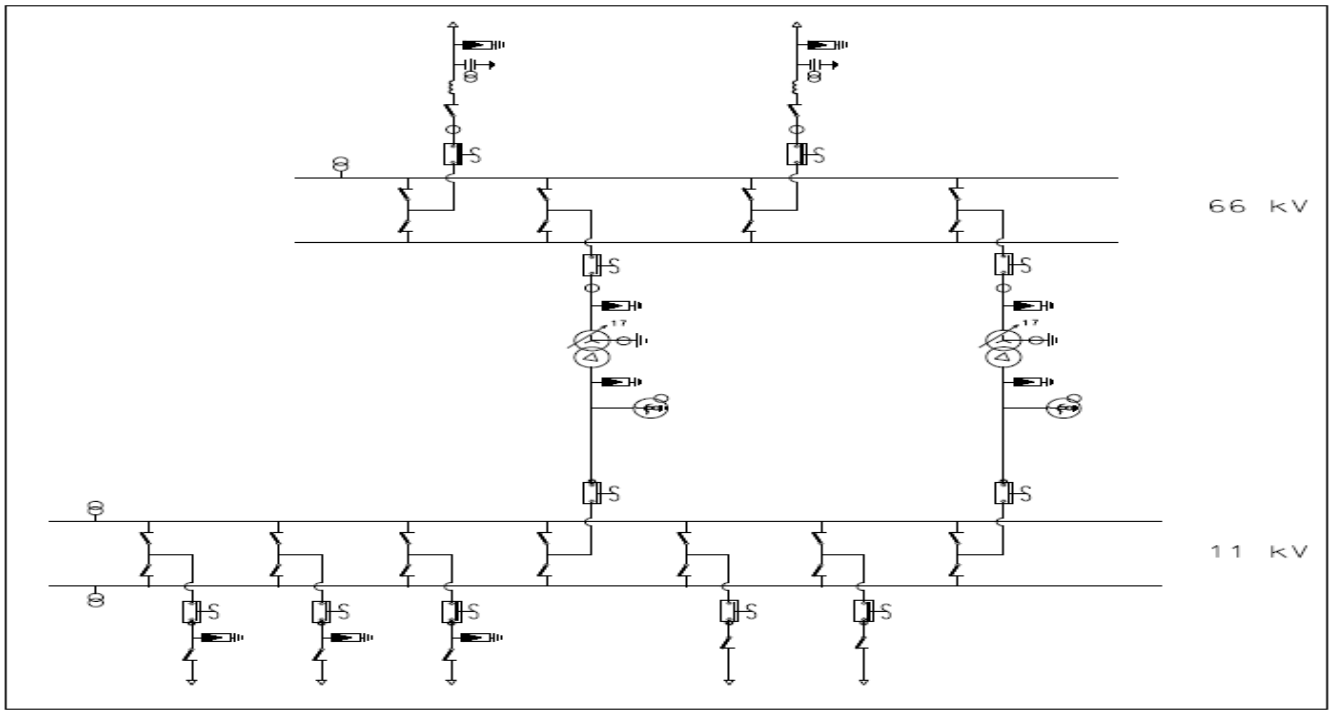
Key Diagram of 11 kV/400 V Sub-Station



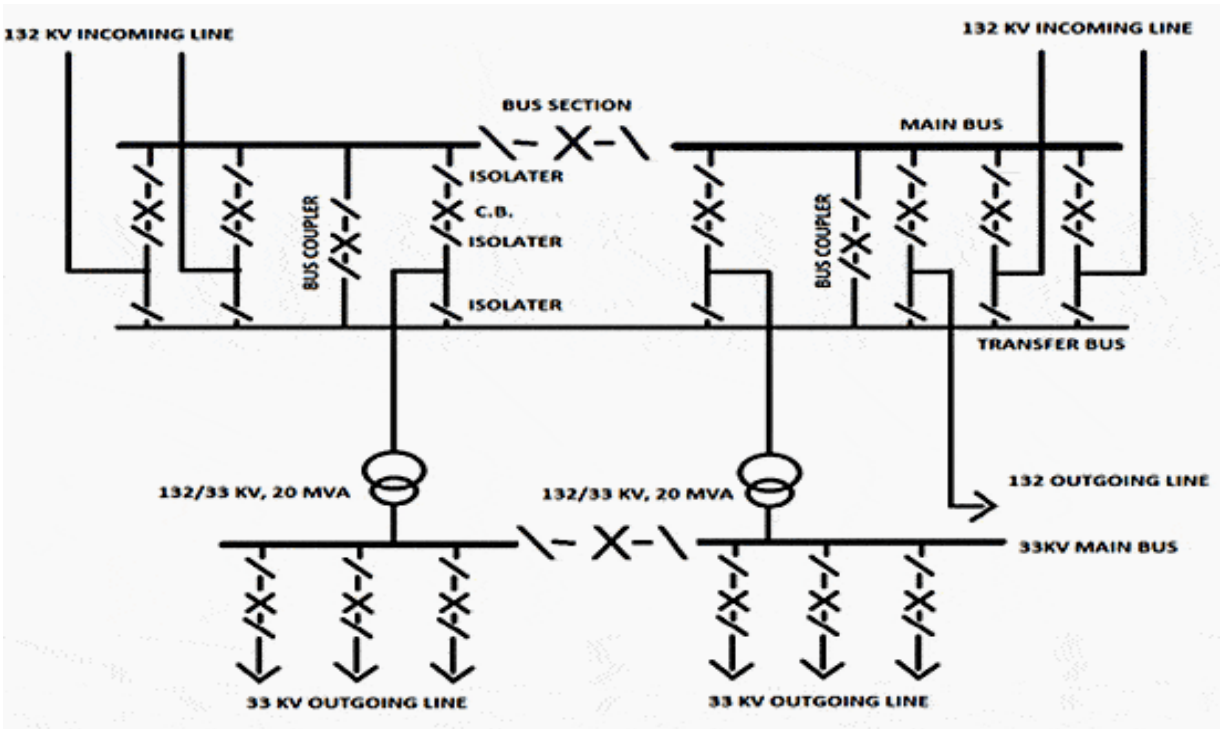
Key Diagram of 33 kV Sub-Station



Key Diagram of 66 kV Sub-Station



Key Diagram of 132 kV Sub-Station



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Multiple choice questions

Q1The size of the earth or ground wire is based on the:
a) maximum fault current carrying through the ground wire
b) rated current carrying capacity of the service line
c) depends on the soil resistance
d) both (a) and (c)

a) copper
b) aluminium
c) iron
d) galvanized steel

a) 500 ohms
b) 1000 ohms
c) 1500 ohms
d) 2000 ohms
Q4. Generally grounding is provided for:
a) only for the safety of the equipment

b) only for the safety of the operating personnel
c) both (a) and (b)
d) none of the above

a) grounding resistance should be as low as possible
b) grounding resistance should be as high as possible
c) grounding resistance should be always zero
d) none of the above

Q6. For an EHV equipment for maintenance first it should be isolated and connected to ground because:
a) to provide low impedance
b) to discharge the charging capacitance to ground
c) protection for operating personnel
d) both (b) and (c)

a) voltage potential at the earth mat increases due to grounding
b) voltage potential at the earth mat decreases due to grounding
c) voltage potential at the earth mat remains zero irrespective of fault
d) none of the above

a) to provide as low resistance possible to the ground
b) to provide as high resistance possible to the ground
c) to provide flow of positive, negative and zero sequence currents
d) none of the above

a) increase
b) decrease
c) does not affect
d) none of the above

a) depth of the electrode
b) moisture
c) Nacl
d) all the above

Short/long answer type Question

Designing and Drawing of

Q1 DOL starting of 3-phase induction motor
Q2 Forwarding/reversing of a 3-phase induction motor
Q3 Star delta starter for 3-phase Induction Motor
Q4 Plate earthing
Q5 Pipe earthing