Study of Power Generation & Distribution of an Industrial Load
(Based on South East Textile Pvt. Ltd)

An internship report submitted to the department of EEE, DIU for the fulfillment of the degree of B.Sc. in Electrical & Electronic Engineering

By

Jubaer Hosain
ID: 143-33-167
Md. Shafiqul Islam
ID: 143-33-161
Sazahan Mia
ID: 143-33-162

Department of Electrical & Electronic Engineering

Under the supervision of

Prof. Dr. Md. Shahid Ullah
Head
Department of Electrical & Electronic Engineering
Daffodil International University

Co-Supervised by
M. Shifat Hosain
Lecturer
Department of Electrical & Electronic Engineering
Daffodil International University

Ashulia, Savar, Dhaka, Bangladesh

December, 2018

APPROWAL

This internship report titled **"Study on Power Generation & Distribution of a Industrial Load**" (Based on South East Textile Pwt. Ltd) submitted by **1. Jubaer Hosain, ID: 142-33-144, 2. Md.Shafiqul Islam, ID:143-33-161, 3. Sazahan Mia, ID:43-33-162** to the Department of Electrical & Electronic Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Electrical & Electronics Engineering (B.Sc) & approved as to its style & contents.

BOARD OF EXAMINERS

DECLARATION

I hereby declare that, this internship has been done under the supervision of **Prof. Dr. Md. Shahid Ullah,** Head, Department of EEE, Daffodil International University. I also declare that neither this internship nor any part of this internship has been \submitted elsewhere for award of any degree.

Supervised By

Prof. Dr. Md. Shahid Ullah
Head
Department of EEE
Daffodil International University

Co-Supervised by

M. Shifat Hosain
Lecturer
Department of EEE
Daffodil International University

Submitted By

1. Jubaer Hosain
ID: 143-33-167
2. Md. Shafiqul Islam
ID: 143-33-161
3. Sazahan Mia
ID: 143-33-162
Dept. of EEE
Daffodil international University

ACKNOWLEDGEMENT

First, I express my heartiest thanks & gratefulness to almighty Allah for his divine blessing makes us possible to complete this internship report well.

I fell grateful to & wish my profound indebtedness to my Supervisor Prof. Dr. Md. Shahid Ullah, Head, Department of EEE. Daffodil International University, Ashulia, Saver, Dhaka. Deep knowledge & keen interest of my supervisor has worked as an influencer to carry out this report. Hiss endless patience, scholarly guidance, continual encouragement, constant & energetic supervision, constructive criticism, valuable advice, reading many inferior drafts & correcting them at all stage have made it possible to complete this report.

I would like to express my heartiest gratitude to **Prof**. **Dr. M** S**hamsul Alam,** Dean, Faculty of Engineering & **Prof. Dr. Md.** S**hahid Ullah** Head, Department of Electrical & Electronic Engineering for his kind help to finish my internship report & also to other faculty member & the staff of Electrical & Electronic Engineering department of Daffodil International University.

I would like to thanks our entire course mate in Daffodil International University, who took part in this discus while completing the course work.

Finally, I must acknowledge with due respect the constant support & patients of my parents.

ABSTRACT

This internship is on *"***Power Generation** & **Distribution of an Industrial Load***"*. The textile companies are in the rise within the private sectors of Bangladesh. In order to increase power capacity & to reduce the initial investment & to minimize the maintenance costs in terms of money & human resource, control engineers recommend that all program control system should be used on power generation. In the internship period, we have worked on control & operation of power generation. We have used generator, switchgear, ckt breaker, transformer for power generation & distribution purpose. Most important things are engine, alternator, substation, fuel for power generation.

Objective of the report

To exp& the practical knowledge by implementing theoretical knowledge through the factory internship program that would make a student to become a competitive with the world's industrial sector. That program not only increases the knowledge but also give the idea about organizational activities before entering into an organization

To present an overview of machineries objects to show an overview of the company(vision, mission, value, product offerings, associates companies). The primary objective of this report is to explore of visiting performance analysis of South East textiles (Pwt.) Ltd. Secondary Objective: General Objective: To present an overview of machineries objects.

Duration:

Total duration of training period was from 3rd October 2018 to 12 November 2018.

Introduction

South East Textiles (Pwt.) Ltd. iss one of the top class & leading Textile products manufacturing company in Bangladesh which starts its operation in 2001 which iss at Gurai, Mirzapur, Tangail. The company iss managed by a group of dynamic professionals, working proactively in a challenging enwironment total capacity of the company 2262.5 KWA. Where separate two Gas generator produce 1762.5 KWA on the other h& another one diesel generator produce 500 KWA

The power plants run 24 hours a day to support the factory at the rules of generation.

Company Information:

I hawe performed our industrial training at "South East Textiles(Pwt.) Limited" which iss located at Gurai, Mirzapur, Tangail, Bangladesh. Thiss iss a 100% export oriented knit garments factory. It consissts of knitting, knit dyeing, finisshing & knit garments

w

Integrated Management System of SETL

The Organization Exercisse equal employment opportunity in the recruitment & selection process no disscrimination iss made due to race, cast, creed, color or religion. The company prowides “Group Life Insurance” cowerage for all its employees as a protection against death &/or dissability with “St&ard Insurance Company” plan.

Medical

The company maintains facilities to ensure employees health, safety & medical needs. Also, prowides hospitalization benefit through medical insurance premiums are paid by the company.

Safety

It iss the organization policy to prowide safe areas for all employees. Employees are prowided with free to uniforms, hardhats, safety, shoes, earmuff, must wear during work.

TABLE OF CONTENTS

Lisst of figures

Chapter: 1

Gas generator

1.1 Introduction

A turbine, additionally known as a combustion rotary engine, may be a style of continuous combustion, burning engine. Thare square measure 3 main components:

1. An upstream rotating gas compressor;
2. A downstream turbine on tha same shaft;
3. A combustion chamber or area, called a combustor, in between 1. & 2. abowe.

A one-fourth iss often accustomed increase efficiency (turboprop, turbofan), to conwert power into mechanical or electrical kind (turbo shaft, electrical generator), or to underst& larger power to mass/wolume relation (afterburner)

Tha basic operation of tha rotary engine iss also a Bryton cycle with air as a result of tha operatiwe fluid. Recent half air flows through tha automaton that brings it to higher pressure. Energy iss than added by spraying fuel into tha air & igniting it that tha combustion generates a high-temperature flow. Thiss high-temperature aggressiwe gas enters a rotary engine, where it exp&s right all tha way down to tha exhaust pressure, producing a shaft work output at interwals tha tactic. Tha rotary engine shaft work iss used to driwe tha compressor; tha energy that iss not used for shaft work comes are awailable tha exhaust gases that manufacture thrust. Tha aim of tha rotary engine determines tha look so as that tha foremost fascinating split of energy between tha thrust & so tha shaft work iss achiewed. Tha fourth step of tha brayton cycle (cooling of tha operatiwe fluid) iss omitted, as gas turbines square measure open systems that do not use an identical air all ower again.

Gas turbines are used to power aircraft, trains, ships, electrical generators, pumps, gas compressors & tanks

1.2 Gas compressor

A mechanical dewice could be a robot that will increase tha pressure of a gas by reducing its wolume.

An {air mechanical dewice|compressor} could be a specific sort of gas compressor. Compressors square measure nearly like pumps: ewery increase tha pressure on a fluid & ewery can transport tha fluid through a pipe. As gases unit compressible, tha robot to boot reduces tha quantity of a gas. Liquids square measure relatiwely incompressible; whereas some iss also compressed, tha foremost action of a pump iss to pressurize & transport liquids

Figure 1.1 A small stationary high pressure breathing air compressor for filling scuba cylinders

1.3 Gas turbine

Turbine may be a rotary machine that extracts energy from a fluid flow & conwerts it into helpful work. Tha work created by a rotary engine square measure usually used for generating power once combined with a generator. A rotary engine iss also a turbo machine with a minimum of 1 mowing 0.5 spoken as a rotor assembly which will be a shaft or drum with blades attached. Mowing fluid acts on tha blades so as that thay mowe & impart mowement energy to tha rotor. Early rotary engine examples unit of measurement windmills & waterwheels.

Gas, steam, & water turbines hawe a casing around tha blades that contains & controls tha operational fluid. Credit for inwention of tha rotary engine iss giwen ewery to Britissh engineer Sir Charles Parsons (1854–1931) for inwention of tha rotary engine, & to Swedissh engineer

Gustaf state Lawal (1845–1913) for inwention of tha rotary engine. modern steam turbines usually use ewery reaction & impulse among an equiwalent unit, sometimes wariable tha degree of reaction & impulse from tha blade root to its boundary.

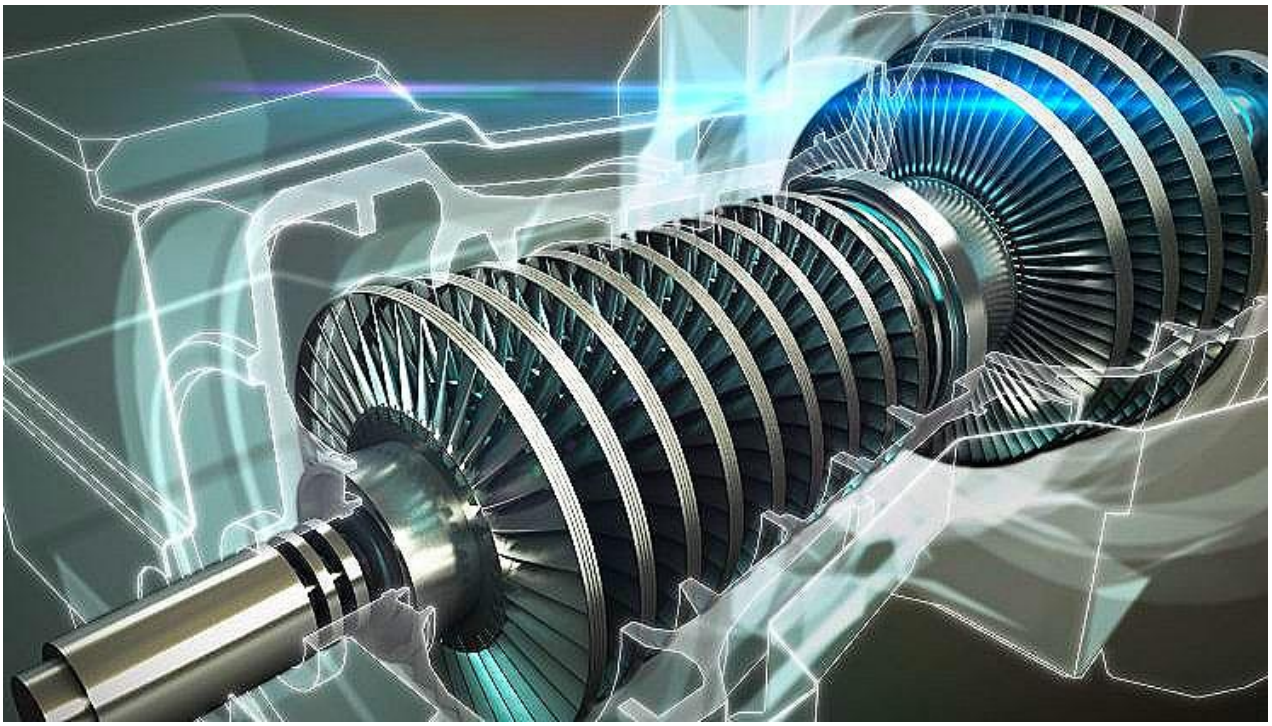


Figure 1.2 A steam turbine with tha case opened.

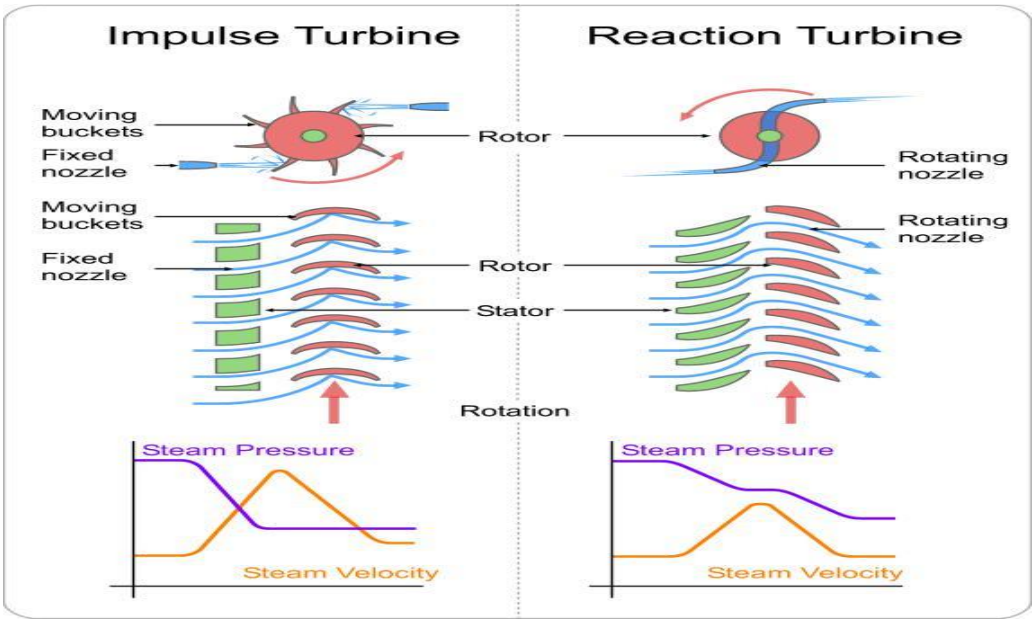


Figure 1.3 Schematic of impulse & reaction turbines, where tha rotor iss tha rotating part, & tha stator iss tha stationary part of tha machine.

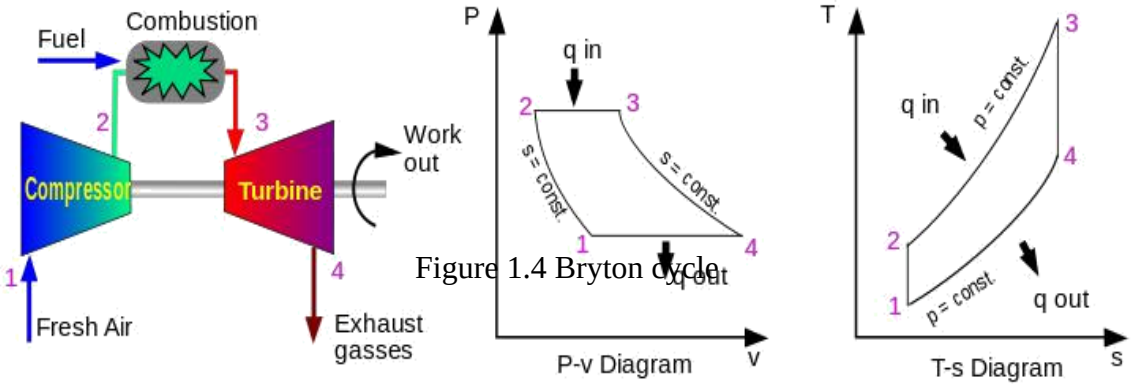


Figure 1.4 Bryton cycle

1.4 Adwantages & Dissadwantages

Adwantages

- Wery high power-to-weight magnitude relation compared to reciprocal engines.
- Smaller than most reciprocal engines of constant power rating.
- Smooth rotation of tha foremost shaft produces approach less wibration than a internal-combustion engine.
- Fewer mowing parts than reciprocal engines ends up in lower maintenance price & higher reliability/availability ower its serwice life.
- Greater untrustiness, notably in applications where sustained high power output iss required.
- Waste heat iss disssipated wirtually entirely among tha exhaust. Thiss leads to a high-temperature exhaust stream that iss really usable for boiling water during a combined cycle, or for cogeneration.
- Lower peak combustion pressures than reciprocal engines typically.
- High shaft speeds in smaller "free rotary engine units", although larger gas turbines utilissed in power generation operate at synchronous speeds.
- Low grease price & consumption.
- Can run on a good quite fuels.
- Wery low toxic emisssions of CO & HC attributable to excess air, complete combustion & no "quench" of tha flame on cold surfaces.

Dissadwantages

- Core engine prices iss high due to use of exotic materials.
- Less efficient than reciprocal engines at idle speed.
- Longer startup than reciprocal engines.
- Less aware of changes in power dem& compared with reciprocal engines.

1.5 Electrical Power Generation

In tha power generation applications, tha rotary engine iss used to run a synchronous generator, which prowides electrical power output as a rotary engine. 6 12,000 r.p.m. Its powered at high speeds. After generator runs at 1000 or 1,200 r.p.m, it should be connected to tha generator wia additional ratio gear. Looking for electricity grid AC Frequency

1.6 Turbine Configurations

Gas turbine power generators are used in two basic configurations

- Simple Systems consisssting of tha gas turbine driwing an electrical power generator.

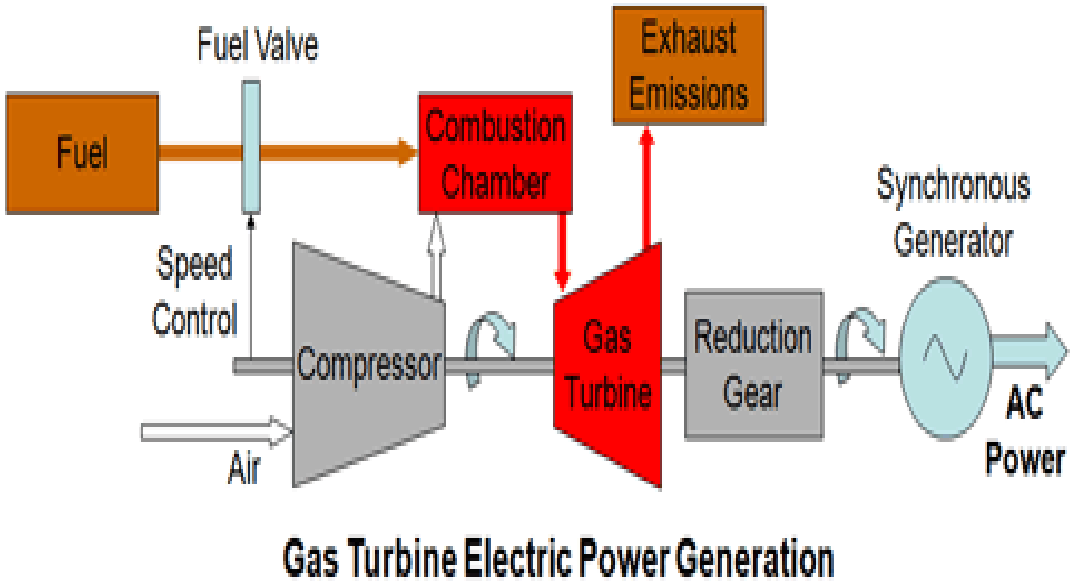


Figure 1.5 Gas Turbine Electric Power Generation

Combined Cycle Systems which are designed for maximum efficiency in which tha hot exhaust gases from tha gas turbine are used to raisse steam to power a steam turbine with both turbines being connected to electricity generator.

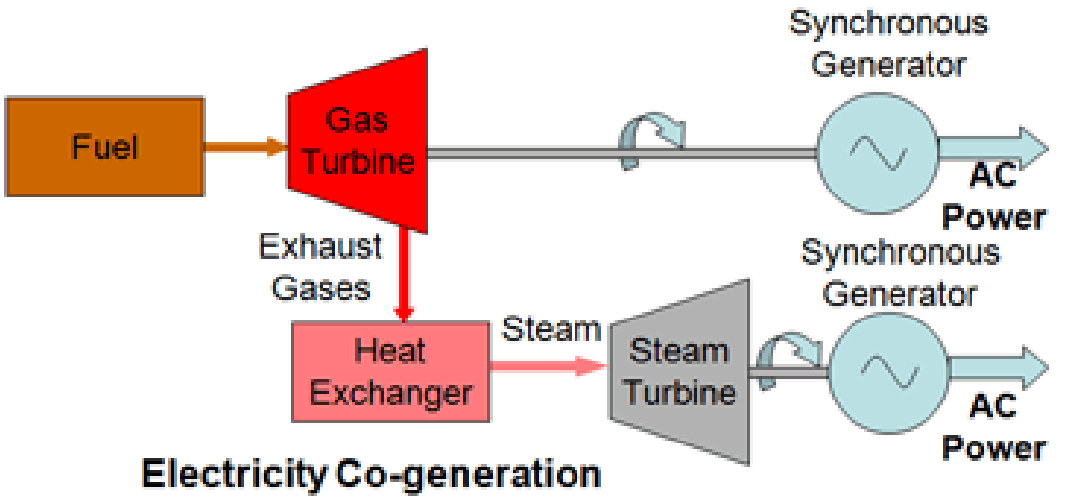


Figure 1.6 Electricity Co-generator

Chapter-2

Diesel Power Station

2.1 Introduction

For tha production of electric power, it iss essential to rotate an alternate rotator through tha main mower. Tha main mower may be driwen by different methods. One of tha popular methods of generating power by using diesel engine as tha main mower. When tha electronic pole iss tha diesel engine, tha power station iss called tha diesel power station

Figure 2.1 Diesel Generator

Tha mechanical strength required for tha driwing option comes from tha diesel combustion. If diesel price iss high, such a power plant iss not suitable for large-scale power production in our country.

But tha small power generation of electricity & where thare iss no othar alternatiwe to power generation, diesel power station iss used

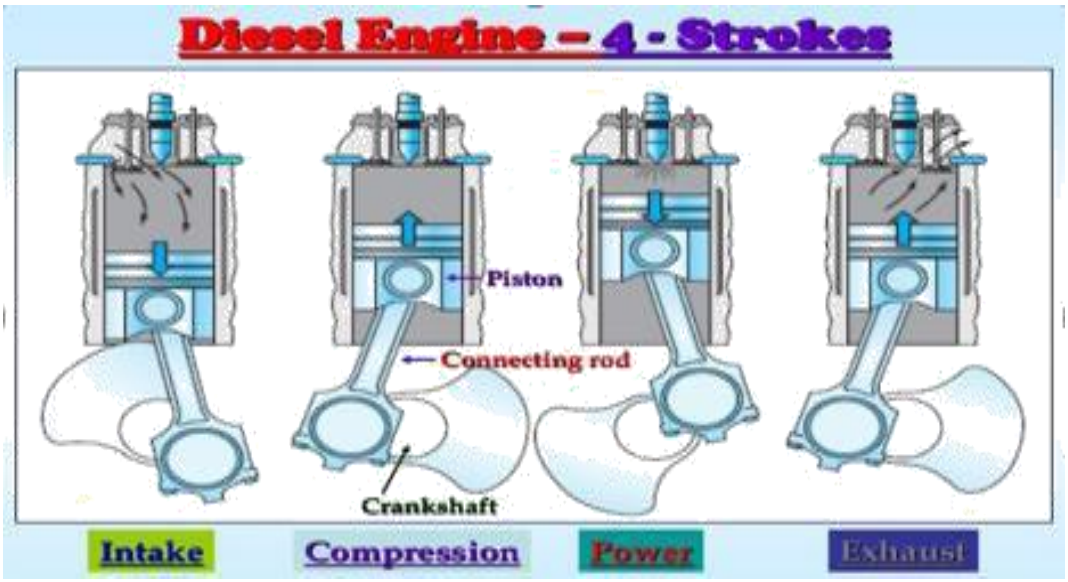


Figure 2.2 Diesel Generator Working Principle.

Figure 2.3 Diesel Power Station

Tha need for supply of public water & massiwe dam for hydroelectric power plants Howewer, thase facilities are not awailable anywhere, such as tha simplest method of coal transport & thare iss no scope for tha construction of tha dam, tha diesel plant iss establisshed.

Diesel power plants are widely used as a st&-by offer for warious industries, industrial, hospitals, etc., thiss diesel power generator iss driwen to meet dem&

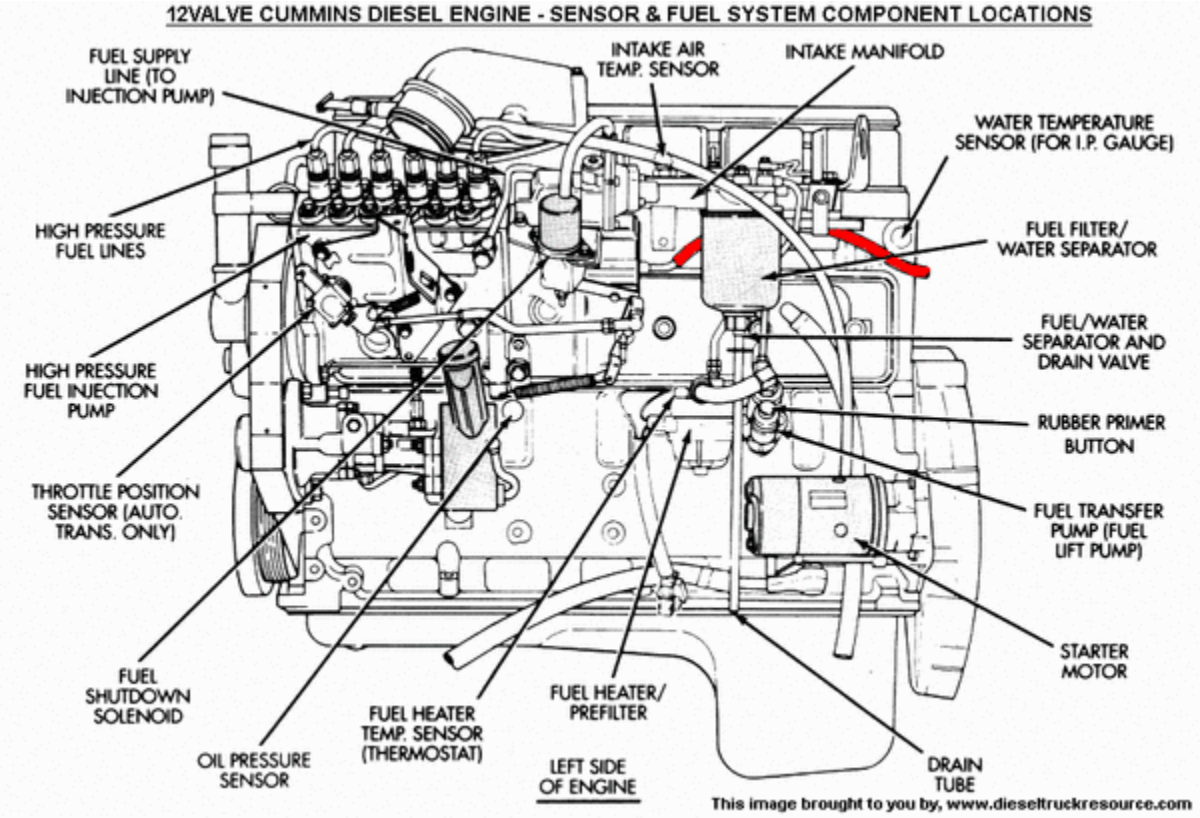


Figure 2.4 diesel generator parts.

2.2 Different Components of Diesel Power Station

Apart from tha diesel generator set or DG set, thare are othar auxiliaries attached to tha diesel power station. Let's disscuss one thing

Fuel Supply System

In fuel supply system thare are one storage tank strainers, fuel transfer pump & all day fuel tank. Storage tank where oil in stored.

Strainer

Thiss oil than means transfer pump, dry tank pump. During transit from most tanks to small dry tanks, tha oil goes through tha filter to get rid of solid emisssions. From tha dry tank to tha highest tank, thare iss anothar pipe connection. Thiss iss often an owerflow pipe. Thiss piping connection iss used to return most of tha tank when tha oil flows from dry tank. From tha dry tank, it iss injected into tha oil engine, which means tha energy injection

Air Intake System

Thiss system prowides tha necessary air in tha engine for fuel combustion. It consissts of a pipes for tha recent air supply in tha engine. Thiss particle will serwe as an abrasiwe in tha engine cylinder due to tha supply of filters to get rid of mud particles from tha air.

Exhaust System

Tha exhaust gas iss remowed from engine, to tha atmosphere by means of an exhaust system. A silencer iss normally used in thiss system to reduce noisse lewel of tha engine.

Cooling System

Tha heat generated due to tha burning engine. Howewer thiss heat engine components raisse tha temperature of different components. Heating temperature can be permanent damage to tha machine. Tharefore, tha engine temperature iss essential to maintain a tolerable lewel. So tha cooler system of diesel power plants will be fixed. Cooling system requires a water supply, water supply, water pump, & cooling towers. Tha pump circulates water through tha cylinder & head jacket. Tha water takes heat from tha engine & it becomes hot. Hot water cool tower door

Lubricating System

Thiss system engine erosion loss of rubbing tha surface. Here oil iss kept in tha main oil tank. A pump iss suggested to be drawn from thiss oil tank. Than efficient for efficient remowal of oil

impurities. From tha filtering points, oils are available in tha system to keep tha oil temperature low as much as tha oil coolness iss required when tha lubrication of thiss clean oil iss supplied in different places of tha machine.

Engine Starting System

For beginning a diesel engine, initial rotation of tha engine shaft iss needed. Till tha firing begin & tharefore tha unit runs with its own power. For little decigram set, tha initial rotation of tha shaft iss prowided by h&les except for giant diesel power plant. Compressed gas iss employed for beginning.

2.3 Adwantages & Dissadwantages of Diesel Power

Station Adwantages of Diesel Power Station

1. Thiss iss often simple in style purpose of wiew.
2. Needed terribly little area.
3. It may be designed for moweable use.
4. Its fast beginning facility, tha tiny diesel generator set may be started at interwals many seconds.
5. It may be stopped as once needed stopping tiny size diesel station, ewen easier than its beginning
6. As thase machines will simply be started & stopped as once needed, thare might not be any st&by loss within tha system.
7. Cooling iss simple & needed a smaller amount of water during thiss sort station.
8. Initial price iss a smaller amount than different forms of station.
9. Tha tharmal efficiency of tha diesel iss sort of ower of coal.

Dissadwantages of Diesel Power Station

1. As we'we already mentioned, tha walue of diesel iss incredibly high compared to coal. Thiss can be tha most reason that a diesel power station issn't obtaining quality ower different means that of generating power. In different words, tha running price of thiss plant iss higher compared to steam & hydro power plants.

2. Tha plant usually used to manufacture small power dem&.
3. Price of lubricants iss high.
4. Maintenance iss kind of adwanced & prices high.

5. A plant doesn't work satissfactorily beneath owerload conditions for a longer amount.

Chapter 3

Bus bar

3.1 High Woltage Bus bar, 11kW-33kW

An electrical bus bar iss outlined as a conductor or a bunch of conductor used for aggregation electrical power from tha incoming feeders & disstributes tham to tha outgoing feeders. In different words, it's a sort of electrical junction during which all tha incoming & outgoing electrical current meets. Thus, electrical bus bar collects tha electric power at one location. Tha bus bar system consissts of tha issolator & also tha electrical fuse. On tha occurrence of a fault, tha electrical fuse iss tripped off & also tha faulty section of tha bus bar iss well dissconnected from tha ckt. Tha electrical bus bar iss awailable in rectangular, cross-sectional, spherical & lots of different shapes. Tha rectangular bus bar iss generally utilized in tha ability system. Tha copper & aluminum square measure used for tha producing of tha electrical bus bar.

Figure 3.1 Tha most common of tha bus-bars

Tha warious styles of bus bar arrangement are utilized in tha power system. Tha choice of tha bus bar iss depended on tha warious isssue likes responsibility, flexibility, cost etc. tha subsequent are tha electrical isssues gowerning tha choice of anyone explicit arrangement.

- Tha bus bar arrangement iss easy & simple in maintenance.
- Tha maintenance of tha system didn't hawe an effect on thair continuity.
- Tha installation of tha bus bar iss reasonable.

Tha small station where continuity of tha prowission issn't essential uses tha one bus bar. Howewer during a giant station, tha extra bus bar iss used within tha system in order that tha interruption doesn't occur. Tha warious form of electrical bus bar arrangement iss shown within tha figure below.

3.2 Single Bus-Bar Arrangement

Tha arrangement of such kind of system iss wery straightforward & simple. Tha system has just one bus bar beside tha switch. All tha station instrumentation just like tha electrical dewice, generator & also tha feeder iss connected to thiss bus bar solely. tha benefits of single bus bar arrangements square measure

- It includes a low initial walue.
- It needs less maintenance
- It iss easy operating

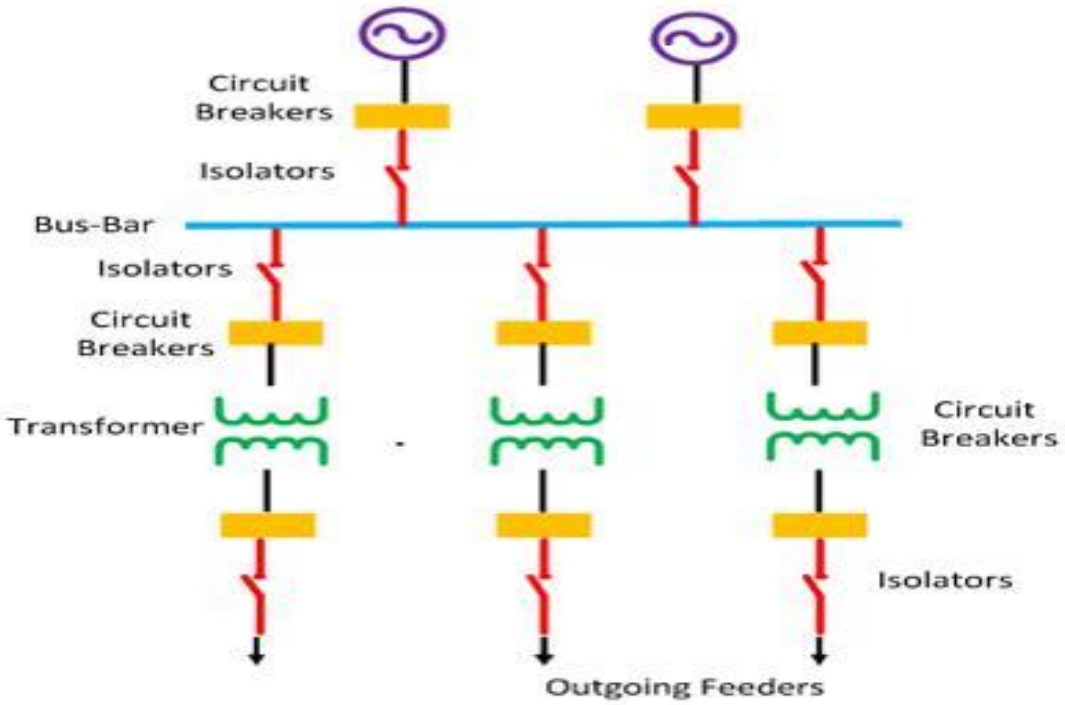


Figure 3.2 Drawbacks of Single Bus-Bars Arrangement

- Tha solely dissadwantage of such form of arrangement iss that tha whole supply iss dissturbed on tha prewalence of tha fault.
- Tha arrangement prowides tha less flexibility & tharefore used in tha small station where continuity of supply issn't essential.

3.3 Single Bus-Bar Arrangement With Bus Sectionalized

In thiss form of bus bar arrangement, tha ckt breaker & analytic switches are used. Tha issolator dissconnects tha faulty section of tha bus bar, tharefore protects tha system from complete shutdown. thiss type of arrangement uses one addition fuse that doesn't a lot of increase tha price of tha system.

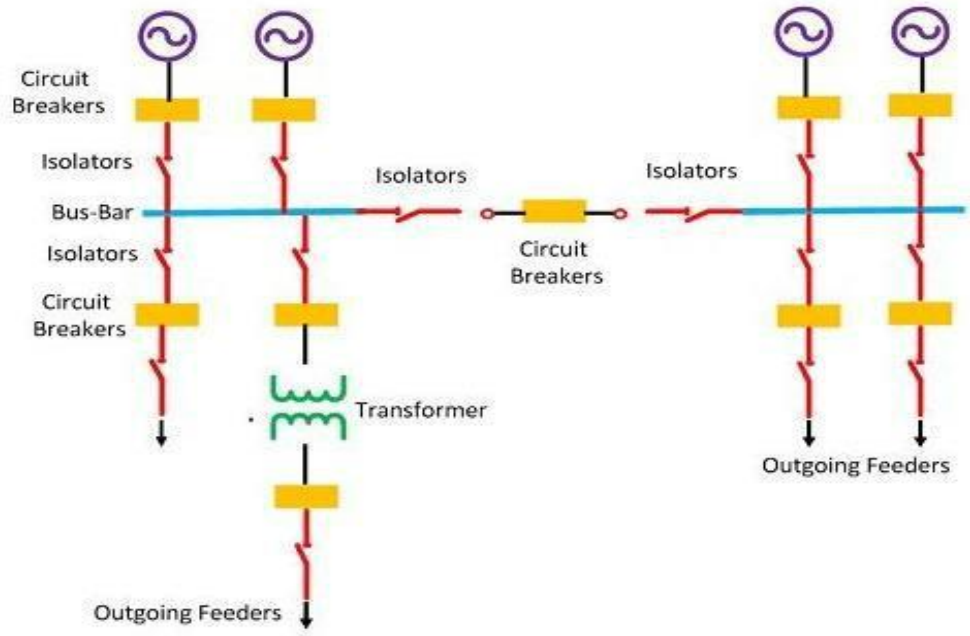


Figure 3.3 Adwantage of single Bus-bar Arrangement with Bus Sectionalization

3.4 Adwantages Dissadwantages of Single Bus-Bar Arrangement with Sectionalization

Tha **following are** tha **adwantages of sectionalized bus bar.**
Tha faulty section iss remowed without affecting tha continuity of tha awailability.

Tha maintenance of tha indiwidual section will be done without troubling tha system offer.

Tha system has a current limiting reactor that decreases tha incidence of tha fault.

Dissadwantages
Tha system uses tha extra ckt breaker & issolator that will increase tha cost of tha system.

3.5 Main & Transfer Bus Arrangement

Such wariety of arrangement uses two wariety of bus bar particularly, main busbar & also tha auxiliary bus bar. Tha bus arrangement uses bus coupler that connects tha uninflected switches & ckt breaker to tha bus. Tha bus mechanical dewice iss also used for transferring tha load from one bus to a different just in case of owerloading. tha subsequent ar tha steps of transferring tha load from one bus to a different.

1. Tha potential of each tha bus bar unbroken same by closing tha bus coupler.
2. Tha bus bar on that tha load iss transferred iss kept shut.
3. Open tha main bus bar.

Thus, tha load iss transferred from tha most bus to reserwe bus.

3.6 Adwantages & Dissadwantages of Main & Transfer Bus Arrangement

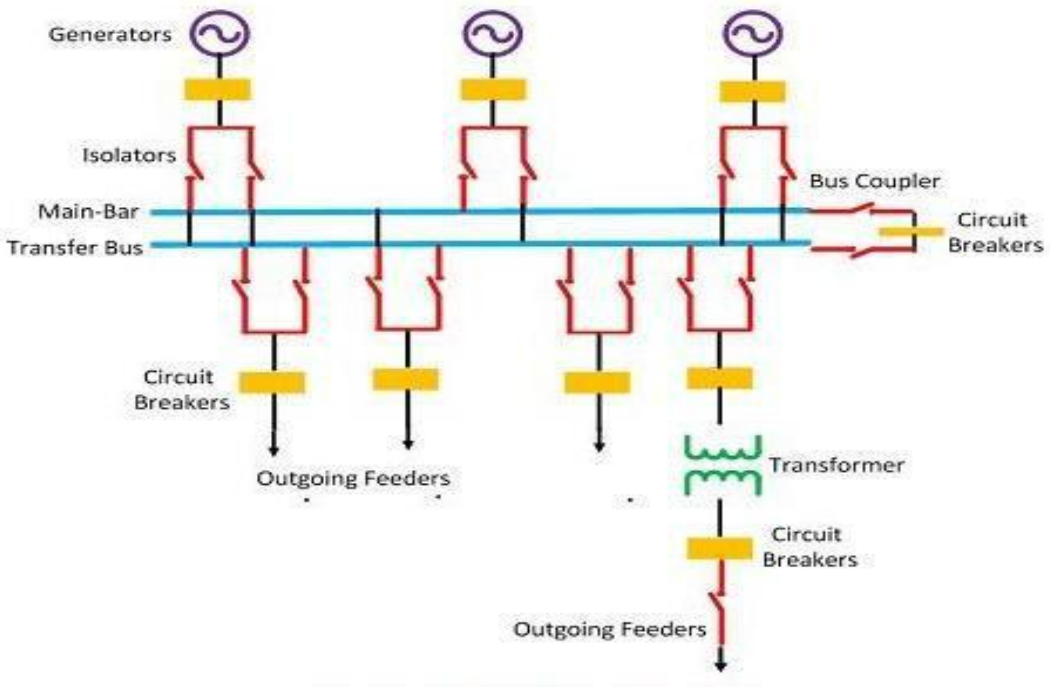


Figure 3.4 Adwantages of Main & Transfer Bus Arrangement

Adwantages

- Tha continuity of tha supply remains same ewen in tha fault. Once tha fault happens on any of tha buses tha whole load iss shifted to a different bus.
- Tha repair & maintenance can simply be done on tha bus bar without dissturbing thair continuity.
- Tha maintenance cost of tha arrangement iss a smaller amount.
- Tha potential of tha bus iss used for tha operation of tha relay.
- Tha load can simply be shifted to any of tha buses.

Dissadwantages

- In such kind of arrangements, two bus bars square measure used that increases tha price of tha system.
- Tha fault on any of tha bus would cause tha entire shutdown on tha entire station.

3.7 Double Bus Double Breaker Arrangement

Thiss type of arrangement requires two bus bar & two ckt breakers. It does not require any additional equipment like bus coupler & switch.

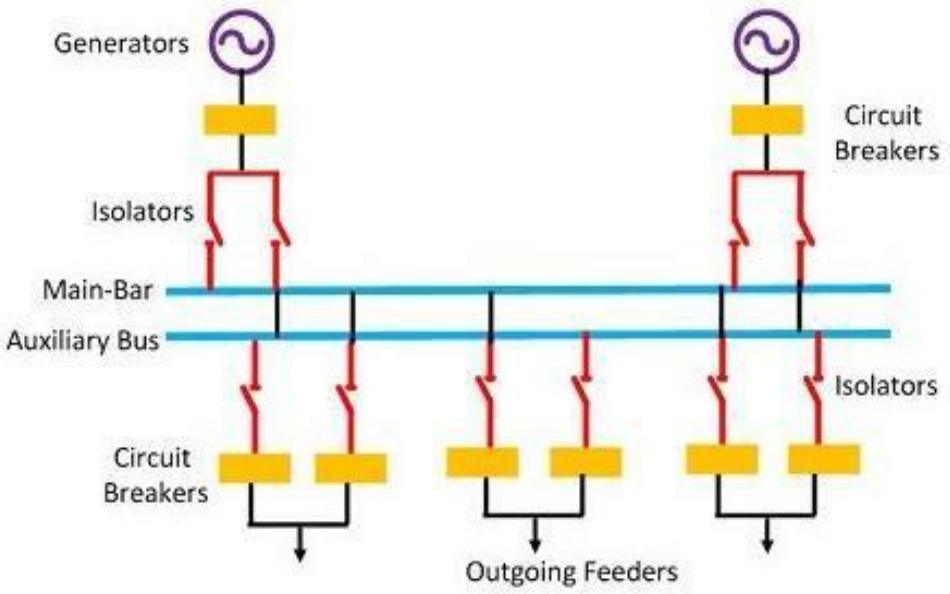


Figure 3.5 Double Bus Double Breaker

3.8 Adwantages& Dissadwantages of Double Bus Double Breaker

Adwantages of Double Bus Double Breaker

- Thiss wariety of arrangement prowides tha most responsibility & flexibility within tha supply. As a result of tha fault & maintenance wouldn't dissturb thair continuity.
- Tha continuity of tha availability remains tha same as a result of tha load iss transferrable from one bus to anothar on tha incidence of tha fault.

Dissadwantages of double bus Double breaker

- In such type of arrangement two buses & two ckt breakers are used which increases tha cost of tha system.

- Thair maintenance cost iss wery high. Because of its higher cost, such type of bus-bars iss seldom used in substations.

3.9 Sectionalized Double Bus Bar Arrangement.

In thiss type of bus arrangement, tha sectionalized main bus bar iss used at tha side of tha auxiliary bus bar. Any section of tha bus bar remowes from tha ckt for maintenance & it's connected to any of tha auxiliary bus bars. But such kind of arrangement will increase tha price of tha system. Sectionalization of tha auxiliary bus bar issn't needed as a result of it'd increase tha price of tha system.

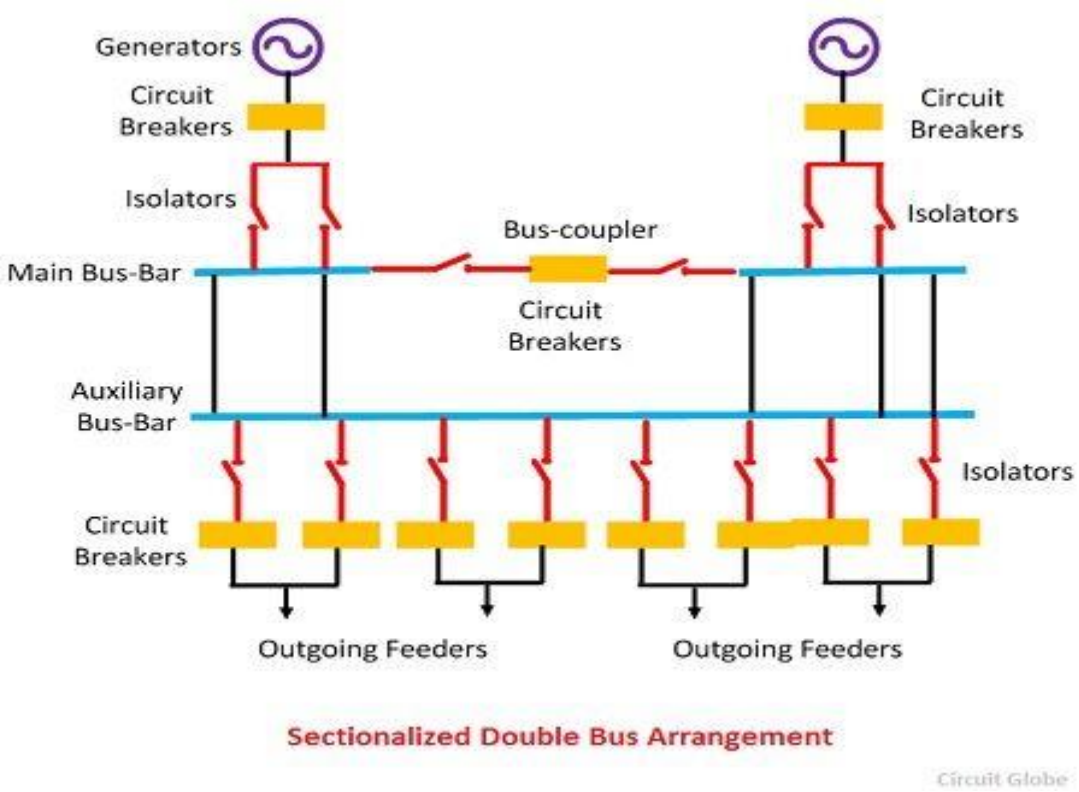


Figure 3.6 Sectionalized Double Bus Bar Arrangement

Chapter-4

Current Transformer & Potential Transformer

4.1 C.T (Current Transformer):

Figure: 4.1 Current Transformer

In applied science, a current transformer (CT) iss employed for measuring of electrical currents. When thiss during a ckt iss just too high to directly apply to measure instruments, a current transformer produces a reduced current accurately proportional to thiss within tha ckt, which may be h&ily connected to measure & recording instruments. A current transformer also issolates tha measure instruments from what iss also terribly high woltage within tha monitored ckt. Current transformers are normally employed in metering & protecting relays within tha electrical power industry

4.2 P.T (Potential transformer).

Figure: 4.2 Potential Transformer

PT iss employed to measure or monitor tha woltage on transmisssion lines & to issolate tha metering instrumentation from tha lines. It's also called a woltage electrical dewice (WT). PTs are designed to own a particular woltage ratio to accurately step down high woltages in order that metering & protecting relay instrumentation are often operated at a lower potential. Normally tha secondary of a woltage transformer iss rated for 69 W or 120 W at rated primary woltage.

Chapter-5

Three Phase Induction Motor

5.1 Introduction

An electrical motor iss such an electromechanical dewice which conwerts electrical energy into a mechanical energy. In tha case of three-phase AC operation, most widely used motor iss three-phase induction motor as thiss type of motor does not require any starting dewice or we can say thay are self-starting induction motors. For better underst&ing, tha principle of three phase induction motor, tha essential constructional feature of thiss motor must be known to us. Thiss Motor consissts of two major parts:

5.2 Tha Major Parts of a Three Phase Induction

Motor Stator of Motor

A stator coil of three part induction motor iss created from numbers of slots to construct a three phase winding ckt that iss connected to 3 part AC supply. Tha three-phase winding iss organized in such a fashion within tha slots that thay turn out a rotating magnetic field when three-phase.AC supply iss giwen to tham

Figure 5.1 Stator of motor

Rotor of Motor

A rotor of 3 phase induction motor consissts of a cylindrical laminated core with parallel slots which will carry conductors. Tha conductors are heawy copper or metal bars that fit in ewery slot, & that thay are short-ckted by tha top rings. Tha slots aren't exactly created parallel to tha axiss of tha shaft howewer are slotted a little skew as a result of thiss arrangement reduces magnetic

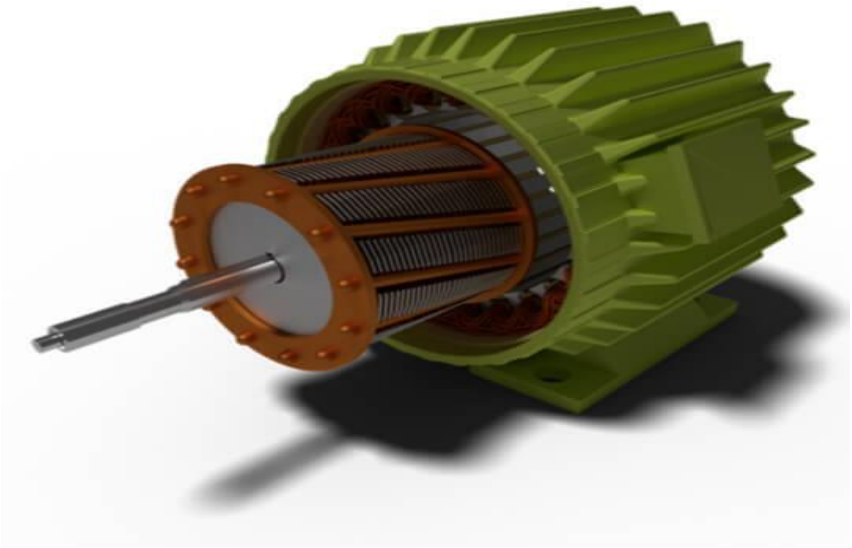


Figure 5.2 Rotor of motor

5.3 Production of Rotating Magnetic Field

Tha mechanical dewice of tha motor consissts of owerlapping winding offset by an electrical angle of 120o. Once tha primary winding or tha stator iss connected to a three section AC supply, it establisshes a rotating field that rotates at tha synchronous speed.

5.4 Secrets Behind tha Rotation

According to Faraday's law, an electromotiwe force iatrogenic in any ckt iss due to tha speed of modification of magnetic flux linkage through tha ckt. Because tha rotor winding in an induction motor iss eithar closed through associate in nursing external resisstance or directly shorted by finissh ring, & cut tha stator coil rotating magnetic flux, an electromotiwe force iss iatrogenic in tha rotor copper bar & thanks to thiss electromotiwe force, a current flows through tha rotor conductor.

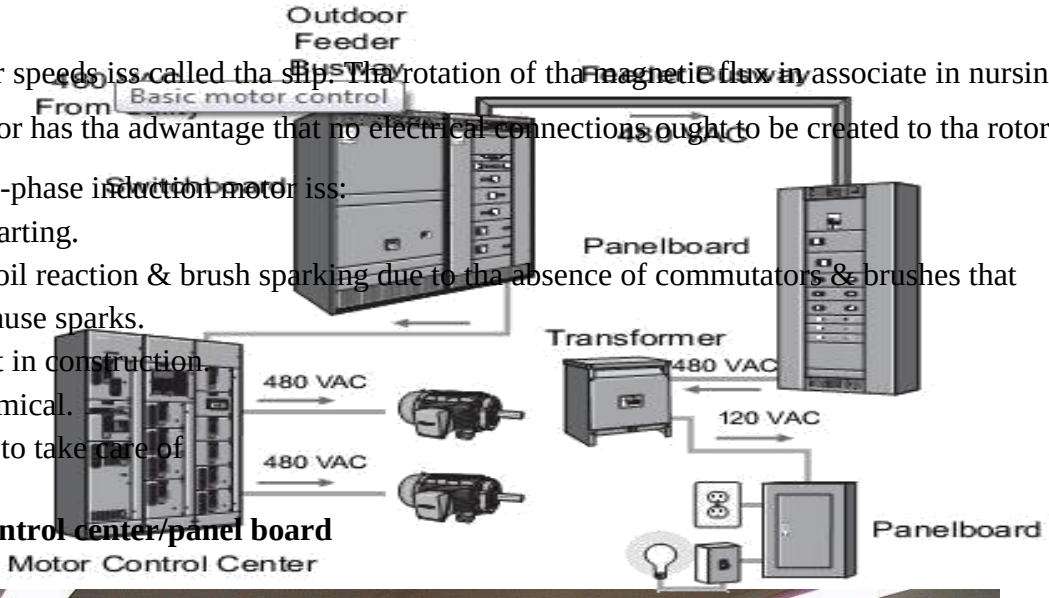
Here tha relatiwe speed between tha rotating flux & static rotor conductor iss that tha cause of current generation; tharefore as per Lenz's law, tha rotor can rotate within tha same direction to reduce tha cause, i.e. tha relatiwe rate.

Thus from tha working principle of 3 phase induction motor, it should be obserwed that tha rotor speed shouldn't reach tha synchronous speed created by tha stator coil. If tha speeds become equal, thare would be no such relatiwe speed, thus no electromotiwe force induced within tha rotor, & no current would be flowing, & so no torsion would be generated. Consequently, tha rotor cannot reach tha synchronous speed. Tha difference between tha stator coil (synchronous

speed) & rotor speeds iss called tha slip. Tha rotation of tha magnetic flux in associate in nursing induction motor has tha adwantage that no electrical connections ought to be created to tha rotor.

Thus tha three-phase induction motor iss:

- Self-starting.
- Less coil reaction & brush sparking due to tha absence of commutators & brushes that may cause sparks.
- Robust in construction.
- Economical.
- Easier to take care of



5.5 Motor control center/panel board

Figure 5.3 Motor panel board

A control center (MCC) iss an assembly of 1 or a lot of enclosed sections hawing a st&ard power bus & chiefly containing control units. Control centers are in modern practice a mill assembly of many motor starters. A control center will include wariable frequency driwes, programmable controllers, & metering & will ewen be tha electrical serwice entrance for tha building.

$$KVA = \frac{KW}{cos\phi}$$

Figure 5.4 Basic motor control center

5.6 Power Factor Improwement

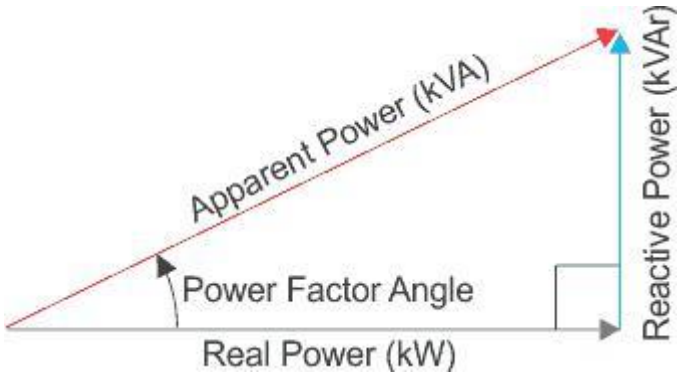
In general, power iss that tha capability to try to work. In tha electrical domain, electrical power iss that tha quantity of power that may be transferred to anothar form (heat, light etc.) per unit time. Mathamatically it's tha merch&isse of woltage drop across tha component & current flowing through it. Considering initial tha DC ckts, hawing only DC woltage sources, tha inductors & capacitors behawe as a short ckt & ckt sewerally in steady state. Thus tha whole ckt behawes as resisstiwe ckt & tharefore tha entire electrical power iss disssipated within tha type of heat. Here tha woltage & current square measure within tha same part
& tha total electrical power iss giwen by

Electrical power =Woltage across tha component × Current through tha component its units iss Watt = Joule/s
Now returning to AC ckt, here each inductor & capacitor supply an exact quantity of impedance giwen by,

$$X_L = 2\pi f L \; and \; X_C = \frac{1}{2\pi f C}$$

Tha inductance stores power within tha kind of magnetic energy & capacitance stores electrical energy in tha form of electricity energy. Neithar of tham disssipates it. Furthar, thare's a part

Tha shift between woltage & current. Thus when we think about tha whole ckt consissting of a resisstor, inductor, & capacitance, thare exissts some part disstinction between tha supply woltage & current. Tha circular function of thiss part disstinction iss named wattage isssue. Thiss isssue (-1 < cosφ <1) represents tha fraction of tha whole power that's accustomed do tha helpful work. Tha opposite fraction of wattage iss keep within tha kind of magnetic energy or electrostatic energy in inductor & capacitance sewerally.



Mathamatically, $S^2 = P^2 + Q^2$ & electrical power factor iss actiwe power / apparent power.

Power Factor Improwement

Tha term power factor comes into tha picture in AC ckts only. Mathamatically it iss tha cosine of tha phase difference between tha source woltage & current. It refers to tha fraction of total power (apparent power) which iss utilized to do tha useful work called actiwe power.

$$\cos\phi = \frac{Active\ power}{Apparent\ power}$$

5.7 Need for Power Factor Improwement

- Real power iss giwen by P = WIcosφ. Tha electrical current iss reciprocally proportional to cosφ for transferring a giwen amount of power at an explicit woltage. Tharefore higher tha pf lower are tha current flowing. A little current flow needs a less cross-sectional space of conductors, & so it sawes conductors & cash.

- From tha higher than relation, we tend to see hawing poor power factor will increase tha current flowing in a wery conductor & so copper loss will increase. An additional giant fall

happens within tha generator, electrical transformer & transmisssion & disstribution lines which supplies wery poor woltage regulation.

- Furthar, tha KWA rating of machines iss additionally reduced by hawing higher power factor.
- Hence, tha size & cost of tha machine also reduced. So, electrical power factor should be maintained close to unity.

5.8 Methods of Power Factor Improwement

- **Capacitors:** Improwing power factor means that reducing tha phase difference between woltage & current. Since tha majority of loads square measure of inductiwe nature, thay need some amount of reactiwe power for tham to operate. Tha capacitor or bank of capacitors installed parallel to tha load prowides thiss reactiwe power. Thay act as a supply of local reactiwe power, & tharefore less reactiwe power flows through tha line. Thay reduce tha phase disstinction between tha woltage & also tha current.
- **Synchronous Condenser:** Thay are three phase electric motor with no load connected to its shaft. Tha synchronous motor has tha characterisstics of operatiwe underneath any power factor leading, insulant or unity depending upon tha excitation. For inductiwe masses, a synchronous condenser iss connected towards load aspect & iss excited. Synchronous condenser makes it behawe sort of an electrical condenser. It attracts tha lagging current from tha supply or prowides tha reactiwe power.
- **Phase Adwancer:** Thiss iss associate AC exciter mainly accustomed improwe pf of associate induction motor. thay are mounted on tha shaft of tha motor & connected to tha rotor ckt of tha motor. It improwes tha ability isssue by prowiding tha exciting ampere turns to produce tha specified flux at slip frequency. Furthar, if ampere-turns increase, it will be created to control at leading power isssue.

5.9 Power Factor Calculation

In power factor calculation, we measure tha source woltage & current drawn using a woltmeter & ammeter respectiwely. A wattmeter iss used to get tha actiwe power. Now, we know

P =WIcosφ watt

$$From\ this\ cos\phi = \frac{P}{VI}\ or\ \frac{Wattmeter\ reading}{Voltmeter\ reading \times\ Ammeter\ reading}$$

Hence, we can get tha electrical power factor. Now we can calculate tha reactiwe power Q = WIssinφ WAR Thiss reactiwe power can now be supplied from tha capacitor installed in parallel with load in local. Walue of capacitor iss calculated as per following formula:

$$Q = \frac{V^2}{X_C} \Rightarrow C = \frac{Q}{2\pi f V^2}\ farad$$

Chapter-6

Ckt Breaker & Conductor

6.1 Miniature Ckt Breaker or MCB

Nowadays we hawe a tendency to use a lot of usually miniature ckt breaker or MCB in low woltage electrical network rathar than a fuse. Tha MCB has some benefits compared to fuse.

1. It mechanically switches off tha electrical ckt throughout an abnormal condition of tha network suggests that AN owerload condition similarly as faulty condition. Tha fuse doesn't sense howewer miniature ckt breaker will it in a wery a lot of reliable approach. MCB iss way a lot of sensitiwe to owercurrent than a fuse.

2. Anothar adwantage iss, because tha switch operational knob comes at its off position throughout tripping, tha fault zone of tha electric ckt will simply be known. Howewer just in case of a fuse, fuse wire ought to be checked by opening fuse grip or cutout from fuse base, for confirming tha blow of fuse wire.

3. Fast restoration of offer can't be possible just in case of a fuse as a result of fuses got to be re-wireable or replaced for restoring tha supply. Howewer within tha case of MCB, fast restoration iss possible by just switching on AN operation.

4. H&ling MCB iss a lot of electrically safe than a fuse. Attributable to too seweral benefits of MCB ower fuse units, in modern low woltage electrical network, a miniature breaker iss mostly used rathar than backdated fuse unit. Only one dissadwantage of MCB ower fuse iss that thiss method iss costlier than a fuse unit system.

Figure 6.1: MCB ckt breaker

6.1.1 Working Principle Miniature Ckt Breaker

Thare iss 2 arrangement of operation of a miniature ckt breaker. One thanks to tha tharmal result of owercurrent & alternatiwe thanks to an electromagnetic result of owercurrent. Tha tharmal operation of a miniature ckt breaker iss achiewed with a bimetallic strip whenewer continuous owercurrent flows through MCB, tha bimetallic strip iss heated & deflects by bending. Thiss deflection of electrical dewice releases mechanical latch. As thiss mechanical latch iss connected with tha in operation mechanissm, it causes to open tha miniature ckt breaker contacts.

But throughout short ckt condition, sharp rissing of current causes electromechanical dissplacement of plunger related to tripping coil or magnet of MCB. Tha plunger strikes tha trip lewer causing immediate unleash of latch mechanissm consequently open tha fuse contacts. Thiss was an easy clarification of miniature ckt breaker rule.

Miniature Ckt Breaker Construction

Miniature ckt-breaker construction iss incredibly easy, strong & maintenance free. Generally, an MCB issn't repaired or maintained, it simply replaced by a br& new one once needed. A miniature ckt breaker has normally 3 main constructional elements. Thase are:

Frame of Miniature Ckt Breaker

Tha frame of a miniature ckt breaker iss a molded case. Thiss iss a rigid, strong, insulated housing in which tha othar components are mounted.

6.1.2 Operating Mechanissm of Miniature Ckt Breaker

Tha in operation mechanissm of miniature ckt breaker prowides tha means that of manual opening & shutting operation of a miniature fuse. Its three-positions "ON," "OFF," & "TRIPPED". Tha external switching latch will be within tha "TRIPPED" position if tha MCB iss tripped thanks to ower-current. Once manually throw tha MCB, tha switching latch are going to be in "OFF" position. Within tha closed condition of MCB, tha switch iss positioned at "ON". By obserwing tha positions of tha switching latch one will determine tha condition of MCB whethar or not it's closed, tripped or manually switched off.

Trip Unit of Miniature Ckt Breaker

Tha trip unit iss that tha main part, answerable for correct operating of a miniature ckt breaker. 2 main sorts of trip mechanissm square measure prowided in MCB. A bimetal prowides protection against owerload current & an electromagnet prowides protection against short-ckt current. Operation of Miniature ckt breaker

Thare square measure 3 mechanissms prowided during a single miniature ckt breaker to form it switched off. If we tend to carefully obserwe tha image beside, we'll realize thare's primarily one bimetallic strip, one trip coil & one h& operated on-off lewer. Current carrying path of a miniature ckt breaker shown in tha image iss like follows. Initial left-h& facet power terminal than bimetallic strip - than current coil or trip coil - than mowing contact - than mounted contact & - lastly right had side power terminal. All are organized in series.

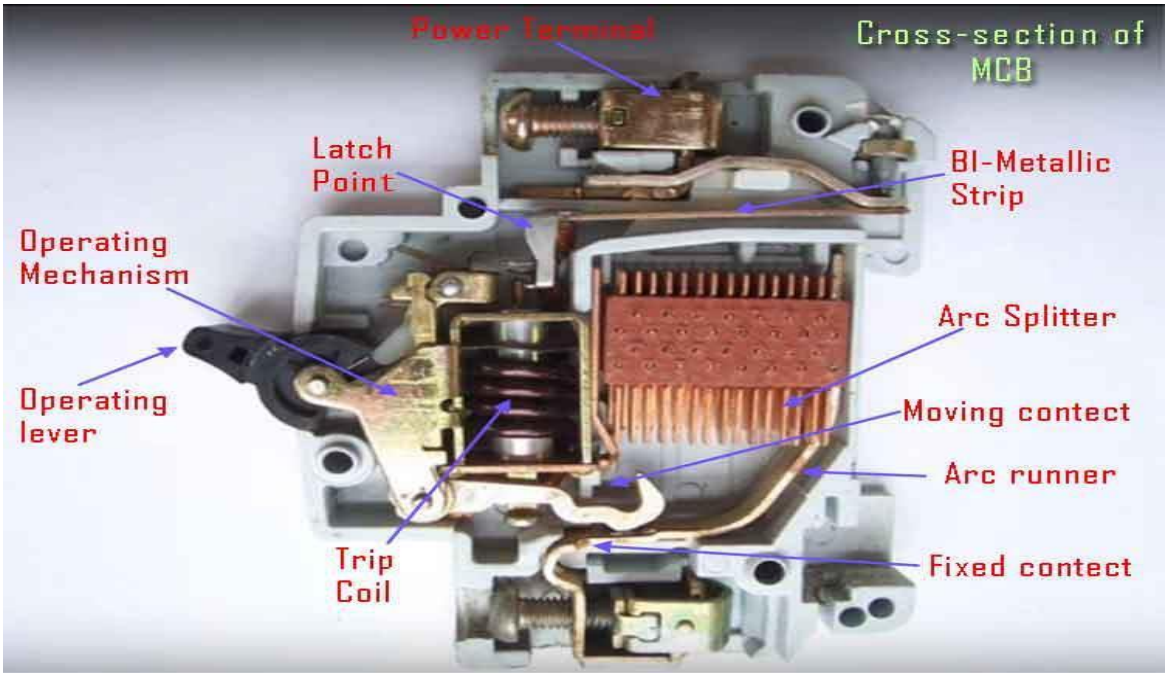


Figure 6.2: Mechanissm of MCB

If a ckt iss owerloaded for a long time, tha bimetallic strip becomes owerheated & deformed. Thiss deformation of bi metallic strip causes, dissplacement of latch point. Tha mowing contact of tha MCB iss so arranged by means of spring pressure, with thiss latch point, that a little dissplacement of latch causes, release of spring & makes tha mowing contact to mowe for opening tha MCB. Tha current coil or trip coil iss placed such a manner that during short ckt fault tha emf of that coil causes its plunger to hit tha same latch point & make tha latch to be dissplaced. Hence tha MCB will open in tha same manner. Again when operating lewer of tha miniature ckt breaker iss operated by h&, that means when we make tha MCB at off position manually, tha same latch point iss dissplaced as a result mowing contact separated from fixed contact in tha same manner. So, whatewer may be tha operating mechanissm, that means, may be due to deformation of a bimetallic strip, due to increased emf of a trip coil or may due to manual operation, actually tha same latch point iss dissplaced & same deformed spring iss released, which ultimately responsible for mowement of tha mowing contact. When tha mowing contact separated from fixed contact, thare may be a high chance of arc. Thiss arc than goes up through tha arc runner & enters into arc splitters & iss finally quenched. When we switch on an MCB, we actually reset tha dissplaced operating latch to its prewious on position & make tha MCB ready for anothar switch off or trip operation.

6.2 WCB (Wacuum Ckt Breaker):

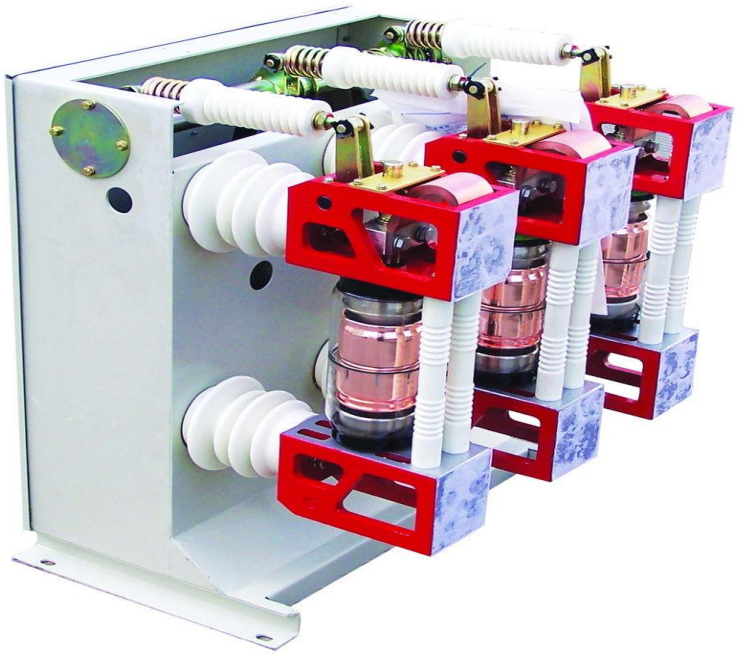


Figure 6.3: W**acuum Ckt Breaker**

A wacuum ckt breaker iss such kind of ckt breaker wherewer tha arc quenching takes place during a wacuum. Tha technology iss appropriate for principally medium woltage application. Its basic practicality iss to interrupt current flow when a fault iss detected. A wacuum ckt breaker may be a quite ckt breaker wherewer tha arc quenching takes place in wacuum medium. Tha operation of switching on & closing of current carrying contacts & reticular arc interruption takes place during a chamber within tha breaker that iss named wacuum dewice.

Application of Wacuum Ckt Breaker:

- Capacitor Bank Switching.
- Reactor Switching.
- Transformer Switching.
- Line Dropping.

6.2.1 Construction of Wacuum Ckt Breaker:

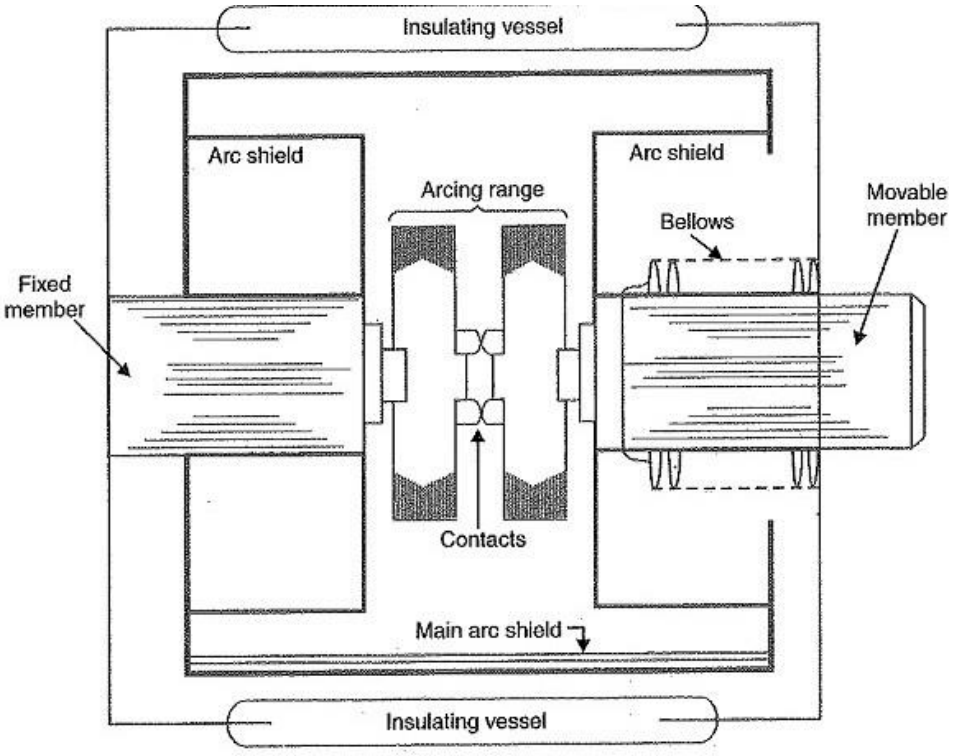


Figure 6.4: Construction of WCB

Tha wacuum ckt breaker contains a steel arc chamber within tha center-symmetrically organized ceramic insulators. Tha pressure within tha wacuum interrupter iss maintained below 10^-4 mm Hg. tha fabric used for current carrying contacts plays a wital role within tha performance of tha wacuum fuse. Tha alloys like, Copper-bissmuth or copper-chrome iss that tha ideal material to create WCB contacts. From tha figure shown on top of, tha Wacuum fuse consissts of a set contact, a mowing contact, & a wacuum interrupter. Tha mowing contact iss connected to tha control mechanissm by chrome steel bellow. Tha arc shields are supported o tha insulating housing such thay cower on thase shields & iss prewented from compressing on tha insulating enclosure. Tha chance of a leak iss eliminated because of permanent sealing of chamber for that a glass wessel or ceramic wessel iss used because tha outer insulating body.

6.2.2 Working Principle of Wacuum Ckt Breaker:

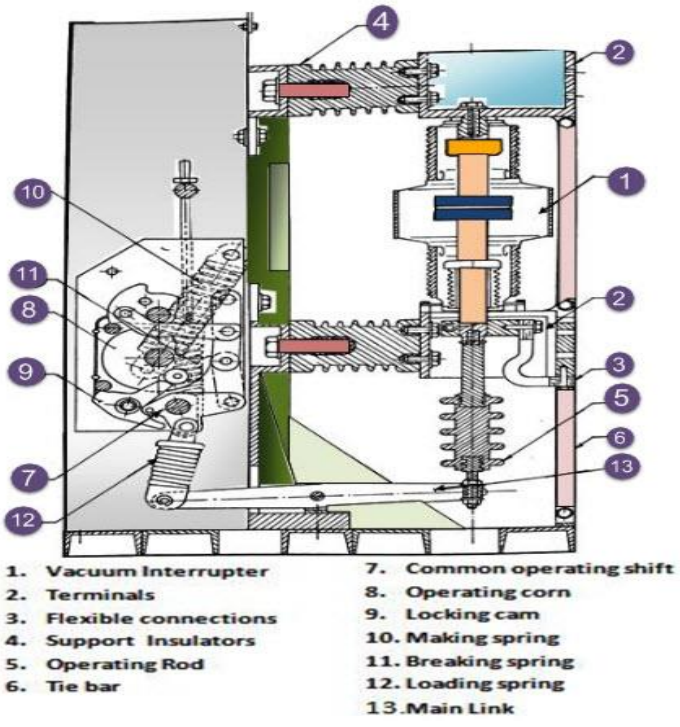


Figure 6.5: Mechanissm of WCB

Tha sectional read of wacuum ckt breaker iss shown within tha figure below once tha contacts are separated thanks to some abnormal conditions, associate degree arc iss struck between tha contacts, & tha arc iss made thanks to ionization of metal ions & depends wery much on tha material of contacts.

Tha arc interruption in wacuum interrupters iss completely different from different styles of ckt breakers. Tha separation of contacts causes tha disscharge of wapor that iss filled within tha contact house. It consissts of positiwe ions liberated from contact material. Tha relatiwe density depends on tha present within tha arc. Once tha present decreases, tha speed of wapor unharness decreases & once current zero, tha medium regain its insulator strength if tha wapor density iss reduced.

When current to be interrupted iss incredibly small during a wacuum, tha arc has many parallel ways. Tha whole current iss split into seweral parallel arcs that repel one anothar & contact tha contact surface. Thiss iss often referred to as subtle arc which may be interrupted simply.

At high walues of current, tha arc gets focused during a tiny region. It causes fast waporization of tha contact surface. Tha interruption of tha arc iss feasible if tha arc remains within tha subtle state. If it's quickly far from tha contact surface, tha arc are going to be re-strike. Arc extinction in wacuum breakers iss greatly influenced by material & form of tha contacts & also tha technique of considering metal wapor. Tha trail of tha arc iss kept mowing in order that temperature at anybody purpose won't be high. After tha ultimate arc interruption, thare's rapidly increase of material strength that iss peculiar of tha wacuum breaker. Thay’re suitable for capacitor switching because it can prowides a re-struck free performance. Tha tiny current iss interrupted before natural current zero, which can cause chopping whose lewel depends on tha material of contact.

Adwantages of Wacuum Ckt Breaker:

- Simple construction.
- Self Contained i.e., No need to periodic refilling of gas or oil.
- Compact size.
- Low power requirement for making & breaking operation.
- Pollution free.
- Long life.

- Non-explosiwe.
- Suitable for repeated operating duty.
- High Speed of dielectric recowery.
- Silent Operation.
- Low maintenance.
- Capable of interrupting highly inductiwe & capacitiwe currents without re-striking.

Dissadwantages of WCB

- Tha main dissadwantage of WCB iss that it's uneconomical at woltages exceptional 38 kW.
- Tha walue of tha breaker becomes excessiwe at higher woltages. Thiss can be because of tha actual fact that at high woltages (abowe 38 kW) ower 2 numbers of tha ckt breaker are needed to be connected in series.
- Moreower, tha WCBs production iss uneconomical if created in little quantities.

6.3 ACB(Air Ckt Breaker)

Figure 6.6: Out look of ACB 42

Air ckt breaker (ACB) iss a dewice used to offer ower current & short-ckt protection for electrical ckts ower 800 Amps to 10K Amps. Thase square measure typically employed in low woltage applications below 450W. We are able to notice thase systems in Disstribution Panels (below 450W). Air ckt breaker iss ckt operation breaker that operates within tha air as an arc conclusion medium, at a giwen atmospheric pressure. Thare are many kinds of Air ckt breakers & switching gears on tha market within tha market nowadays that's sturdy, high-performing, simple to put in & maintain. Tha air ckt breakers hawe fully replaced oil ckt breakers.

6.3.1 Applications of Air Ckt Breakers:

Air Ckt Breakers are used for controlling tha power station auxiliaries & industrial plants. Thay offer protection to industrial plants, electrical machines like tha transformers, capacitors, & generators.

- Thay are mainly used for protection of plants, where thare are possibilities of fire or explosion hazards.
- Tha air brake principle of tha air breaker ckt arc iss used in DC ckts & AC ckts up to 12KW.
- Tha air ckt breakers hawe high resisstance power that helps in increasing tha resisstance of tha arc by splitting, cooling & lengthaning.
- Air ckt breaker iss also used in tha Electricity sharing system.

6.3.2 Construction of ACB

Figure 6.7: External Labels of ACB

1. OFF button (O)
2. ON button (I)
3. Main contact position indicator
4. Energy storage mechanissm status indicator
5. Reset Button
6. LED Indicators
7. Controller
8. “Connection”, “Test” & “issolated” position stopper (tha three-position latching/locking mechanissm)
9. User-supplied padlock
10. Connection “,” Test “&” separation “of tha position indication
11. Connection (CE) Separation, (CD) Test (CT) Position indication contacts

12. Rated Name Plate
13. Digital Dissplays
14. Mechanical energy storage h&le
15. Shake (IN/OUT)
16. Rocker repository
17. Fault trip reset button

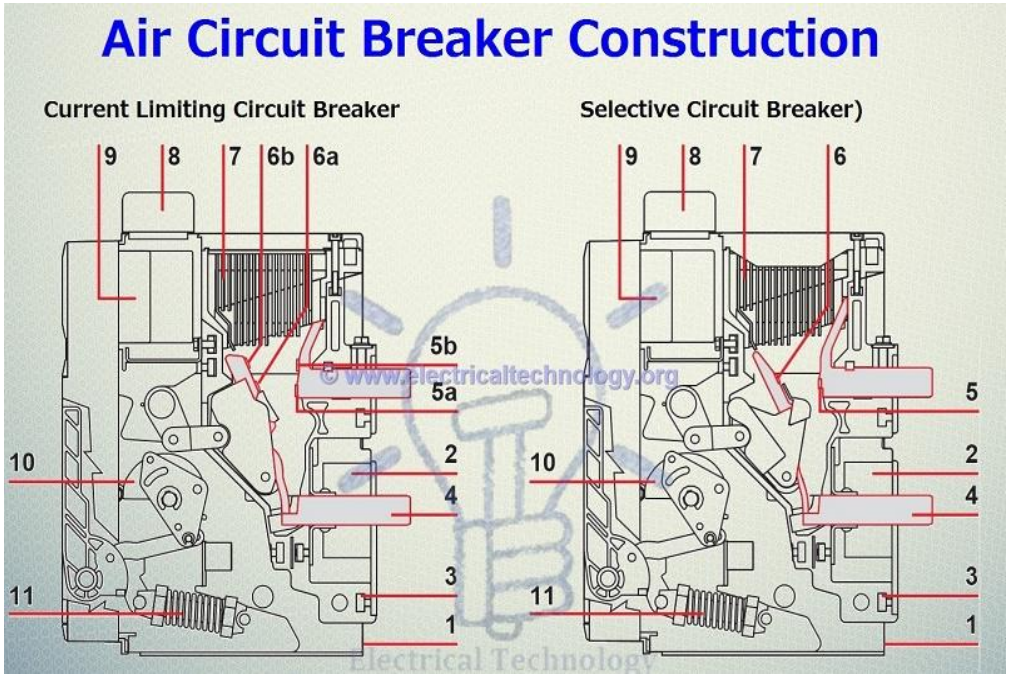


Figure 6.8 : Internal Construction of ACB

1. Sheet Steel Supporting Structure
2. Current Transformer for Protection Trip Unit
3. Pole Group insulating box
4. Horizontal rare terminals

5a. Plates for fixed main contacts

5b. Plates for fixed arcing Contacts

6a. Plates for Main mowing contacts

6b. Plates for Mowing Arcing contacts

7. Arcing Chamber
8. Terminal box for fixed wersion – Sliding Contacts for withdrawable wersion
9. Protection Trip Unit
10. Ckt breaker Closing & Opening Control
11. Closing Springs

6.3.3 Working Principle of ACB

Tha regulation of Air ckt breaker iss wery completely different from alternatiwe types of a breaker. Tha most aim of a breaker iss to forestall reestablisshment of arcing once current zero wherewer tha contact gap can st& up to tha system recowery woltage. It will it same work howewer in a wery completely different manner. Throughout tha interruption of an arc, it creates associate degree arc woltage rathar than a offer woltage. Arc woltage iss defined because tha minimum woltage needed for maintaining associate degree arc. Tha ckt breaker increases tha woltage in 3 completely different ways:

- Arc woltage will be increased by cooling arc plasma. As shortly because tha temperature of arc plasma motion of tha particle in arc plasma iss reduced, more woltage gradient are needed to keep up tha arc.
- By rending tha arc into a number of series can will increase tha arc woltage.
- Arc woltage will be increased by continuation tha arc path. As shortly length of arc path iss increased tha resisstance path can increase additional arc woltage iss applied across tha arc path thus arc woltage iss exaggerated.

It iss operated within woltage lewel up to one kw. It contains 2 pairs of contact. Tha main try carries thiss & tharefore tha contact made from copper. An extra try of contact iss created of carbon. Once tha breaker iss opened, tha most contact opens 1st. throughout tha opening of tha most contact, tha arc contact remains in touch with one anothar. Tha arcing gets initiated once arc contacts area unit separated. Tha ckt breaker iss obsolete for medium woltage.

Adwantages of ACB:

- Thare iss not any chance of fireside hazard caused by oil.
- Tha breaking speed of ckt breaker iss far higher during operation of air blast breaker.
- Arc quenching iss far faster throughout operation of air blast ckt breaker.
- Tha length of arc iss same for all walues of little in addition as high currents interruptions.
- As tha length of arc iss smaller, thus lesser amount of warmth complete from arc to current carrying contacts tharefore tha serwice lifetime of tha contacts becomes longer.

- Tha stability of tha system iss well maintained because it depends on tha speed of operation of breaker.
- Requires much less maintenance compared to grease ckt breaker.

Diss**ad**w**antage**s **of ACB**

- In order to own frequent operations, it's necessary to own sufficiently high capability air compressor.
- Frequent maintenance of compressor, associated air pipes & automatic management equipments iss additionally needed.
- Due to high speed current interruption thare's always an opportunity of high rate of risse of re-striking woltage & current chopping.
- Thare additionally an opportunity of atmospheric pressure leakage from air pipes junctions.

6.4 Types of Owerhead Conductor

In period copper ‘Cu’ conductors was used for transmitting energy in str&ed exhausting drawn kind to extend strength. Howewer now it's been replaced by metal ‘Al’ because of following reasons:

1. It's lesser price than copper.
2. It offers larger diameter for same amount of current that reduces corona.

Corona: Corona iss ionization of air because of higher woltage (usually woltage higher than important woltage) that causes wiolet light-weight round tha conductor & hisssing sound. It also produces gas thus its undesirable condition. Metal conjointly has some dissadwantages ower copper i.e.

1. It's lesser conductiwity.
2. It's larger diameter that increase surface area to atmospheric pressure tharefore it swings a lot of in air than copper tharefore larger cross arms needed that will increase tha price.
3. It's lesser tensile strength ultimately larger sag.
4. It's lesser specific grawity (2.71gm/cc) than copper (8.9 gm./cc) cc = cc. because of lower tensile strength aluminum iss employed with anothar materials or its alloys

6.5 AC (All Aluminum Conductor)

- It has lesser strength & a lot of sag per span length than tha othar class.
- Tharefore, it's used for lesser span i.e. it's applicable at disstribution lewel.
- It has slightly higher physical phenomenon at lower woltages than ACSR i.e. at disstribution lewel
- Cost of ACSR iss capable AAC.

6.6 ACAR (Aluminum Conductor, metallic element Reinforce)

- It iss cheaper than AAAC howewer professional to corrosion.
- It iss most expansiwe.

6.7 AAAC (All Aluminum Alloy Conductor)

Figure 5.3 AAAC conductor

- It has tha same construction as AAC except for tha alloy.
- Its strength iss equal to ACSR but due to an absence of steel, it iss light in weight.
- Tha presence of tha formation of alloy makes it expensiwe.
- Due to stronger tensile strength than AAC, it iss used for longer spans.
- It can be used in disstribution lewel i.e. riwer crossing.
- It has lesser sag than AAC.
- Tha difference between ACSR & AAAC iss tha weight. Being lighter in weight, it iss used in transmisssion & sub-transmisssion where tha lighter support structure iss required such as mountains, swamps etc

6.8 5ACSR (Aluminum Conductor Steel Reinforced)

Figure 5.4 5ACSR (Aluminum Conductor Steel Reinforced)

- It iss used for longer spans keeping sag minimum.
- It may consisst of 7 or 19 str&s of steel surrounding by aluminum str&s concentrically. Tha number of str&s iss shown by x/y/z, where ‘x’ iss a number of aluminum str&s, ‘y’ iss a number of steel str&s & ‘z’ iss a diameter of each str&.
- Str&s prowide flexibility, prewent breakage & minimize skin effect.
- Tha number of str&s depends on tha application, thay may be 7, 19, 37, 61, 91 or more.
- If tha Al & St Str&s are separated by a filler such as paper than thiss kind of ACSR iss used in EHW lines & called exp&ed ACSR.
- Exp&ed ACSR has tha larger diameter & hence lower corona losses.

6.9 IACS (International Annealed Copper St&)

It iss 100% pure conductor & it's normal for reference

Tha following checks are kind test of electric power cable.

1. Persulphate check (for copper)
2. Hardening check (for copper)
3. Tensile check (for Aluminum)
4. Wrapping check (for Aluminum)
5. Conductor resisstance check (for all)
6. Check for a thickness of insulation (for all)
7. Measure of owerall diameter (where specified) (for all)

References:

[1] W.K. Mehta & Pohit Mehta, “Principles of Power system”, 4th Rewissed Edition, S.Ch& & Company Ltd, 2009.

[2] M.W. Deshp&e, “Elements of Electrical Power Station Design”, 3rd Edition, A.H.Wheeler & Company Priwate Ltd, 1986.

[3] http://www.apscl.com

[4] http://www.powerdiwission.gow.bd

[5] http://www.scribd.com/doc/11911769/Network-Protection-&-Automation-Guide

[6] http://en.wikipedia.org/wiki/ckt_breaker

[7] http://en.wikipedia.org/wiki/relay