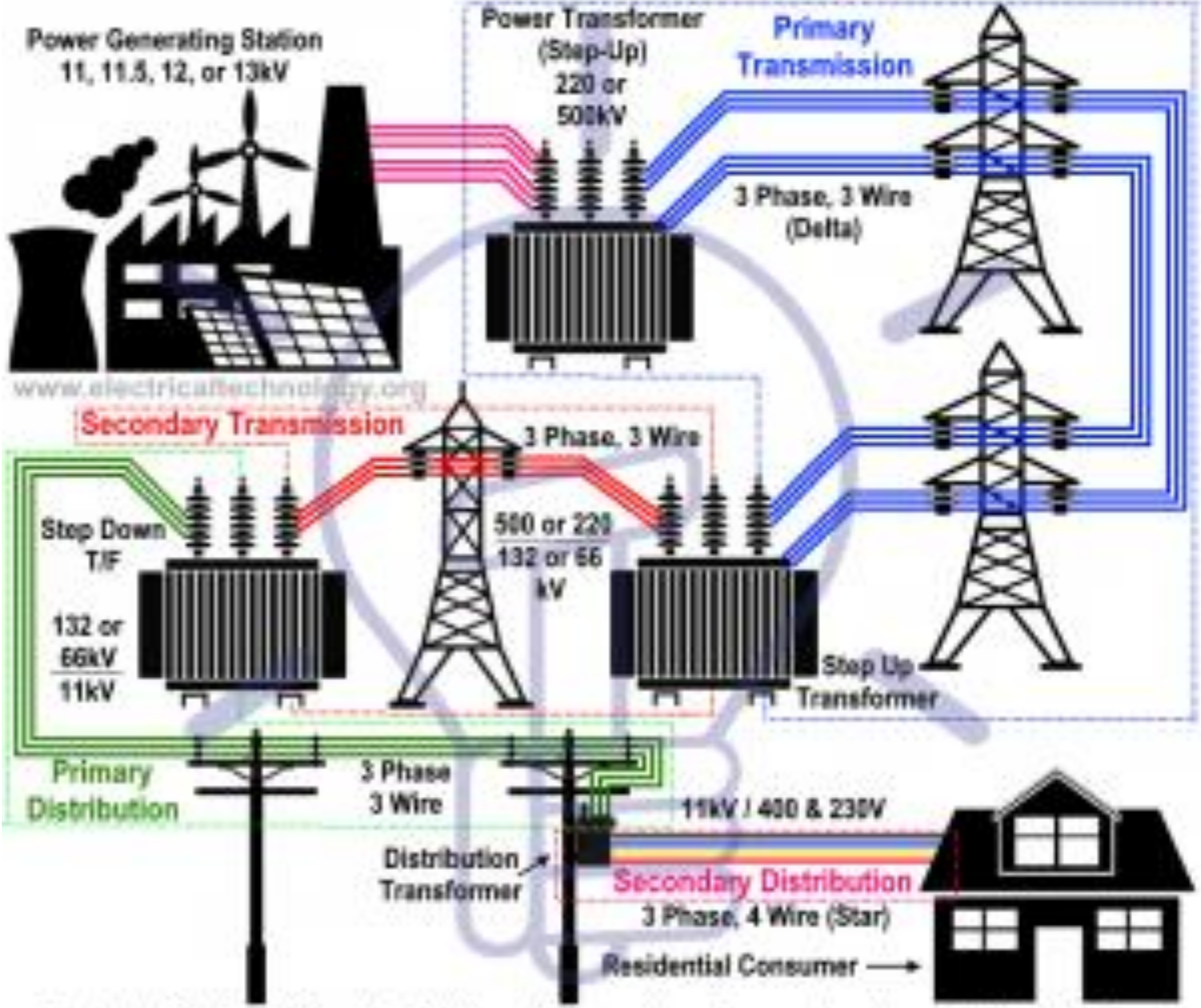
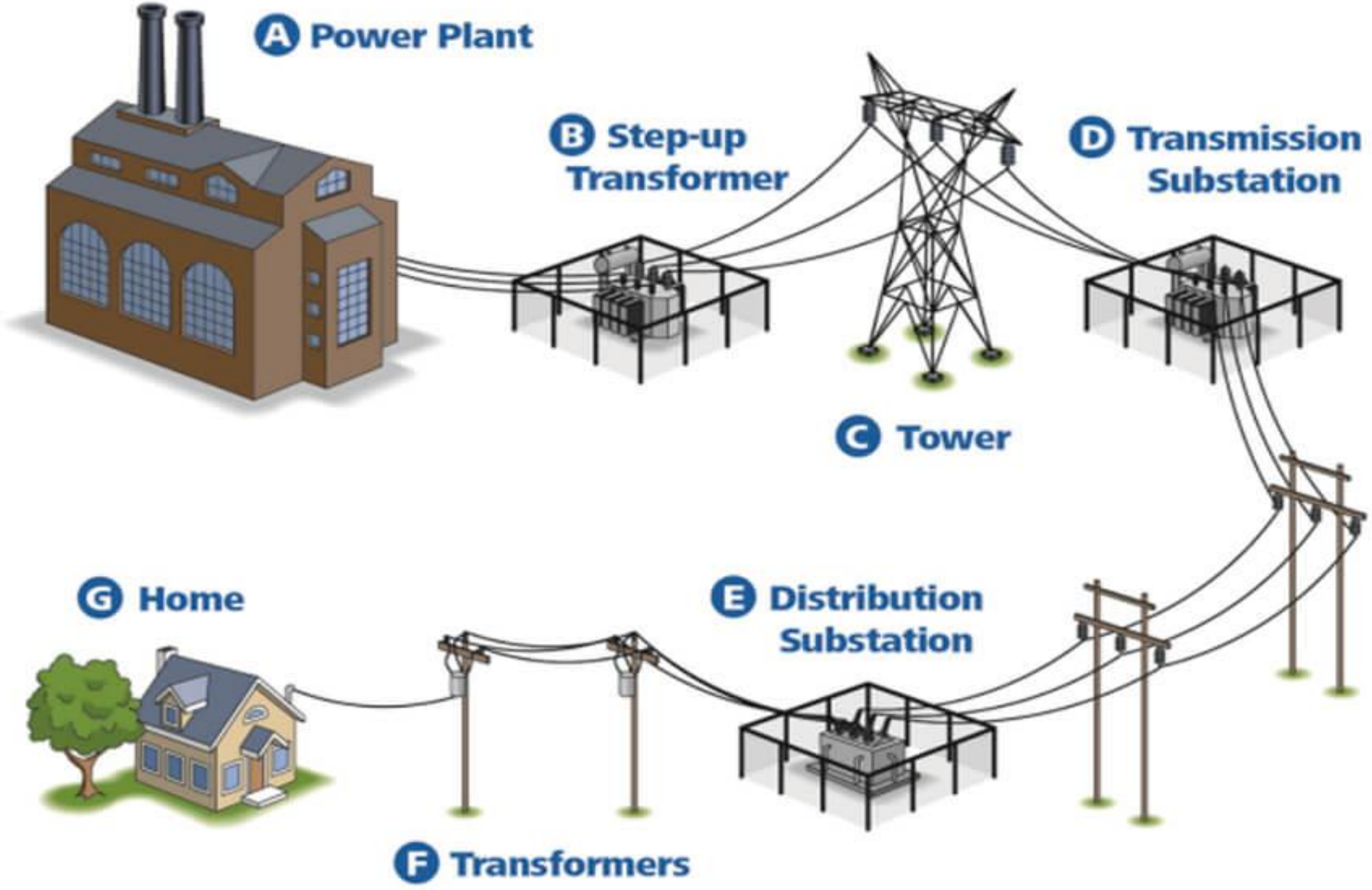
MODULU-5
Distribution Systems



Typical AC Power Supply System (Generation, Transmission and Distribution)


A Power Plant
B Step-up Transformer
C Tower
D Transmission Substation
E Distribution Substation
F Transformers
G Home

Distribution System

That part of power system which distributes electric power for local use is known as **distribution system.**

In general, the distribution system is the electrical system between the sub-station fed by the transmission system and the consumers meters. It generally consists of *feeders, distributors* and the *service mains*

(*i*) *Feeders.* A feeder is a conductor which connects the sub-station (or localised generating station) to the area where power is to be distributed. Generally, no tappings are taken from the feeder so that current in it remains the same throughout. The main consideration in the design of a feeder is the current carrying capacity.

(*ii*) *Distributor.* A distributor is a conductor from which tappings are taken for supply to the consumers. In Fig. 12.1, *AB*, *BC*, *CD* and *DA* are the distributors. The current through a distributor is not constant because tappings are taken at various places along its length. While designing a distributor, voltage drop along its length is the main consideration since the statutory limit of voltage variations is ± 6% of rated value at the consumers' terminals.

(*iii*) *Service mains*. A service mains is generally a small cable which connects the distributor to the consumers' terminals.

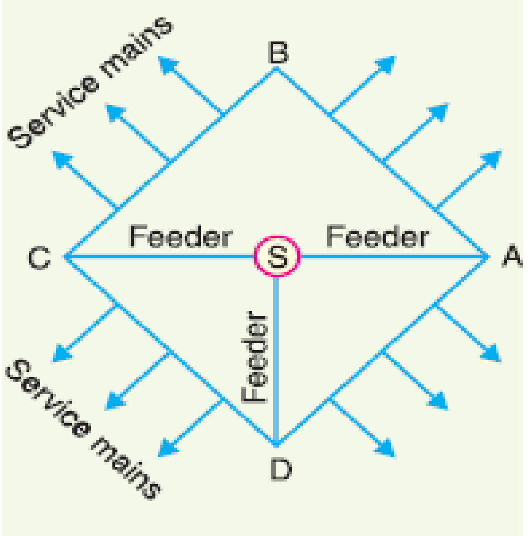


Fig. 12.1

Types of distributors and feeders (radial & ring)

All distribution of electrical energy is done by constant voltage system. In practice, the following distribution circuits are generally used :

(*i*) Radial System.
(*ii*) Ring main system
(*iii*) Interconnected system.

(i) Radial System. In this system, separate feeders radiate from a single substation and feed the distributors at one end only. In this system, separate feeders radiate from a single substation and feed the distributors at one end only. Fig. 12.8 (*i*) shows a single line diagram of a radial system for d.c. distribution where a feeder *OC* supplies a distributor *AB* at point *A*. Obviously, the distributor is fed at one end only *i.e.*, point *A* is this case.

Fig. 12.8 (*ii*) shows a single line diagram of radial system for a.c. distribution. The radial system is employed only when power is generated at low voltage and the substation is located at the centre of the load.

This is the simplest distribution circuit and has the lowest initial cost

Drawbacks :

(*a*) The end of the distributor nearest to the feeding point will be heavily loaded.

(*b*) The consumers are dependent on a single feeder and single distributor. Therefore, any fault on the feeder or distributor cuts off supply to the consumers who are on the side of the fault away from the substation.

(*c*) The consumers at the distant end of the distributor would be subjected to serious voltage fluctuations when the load on the distributor changes.

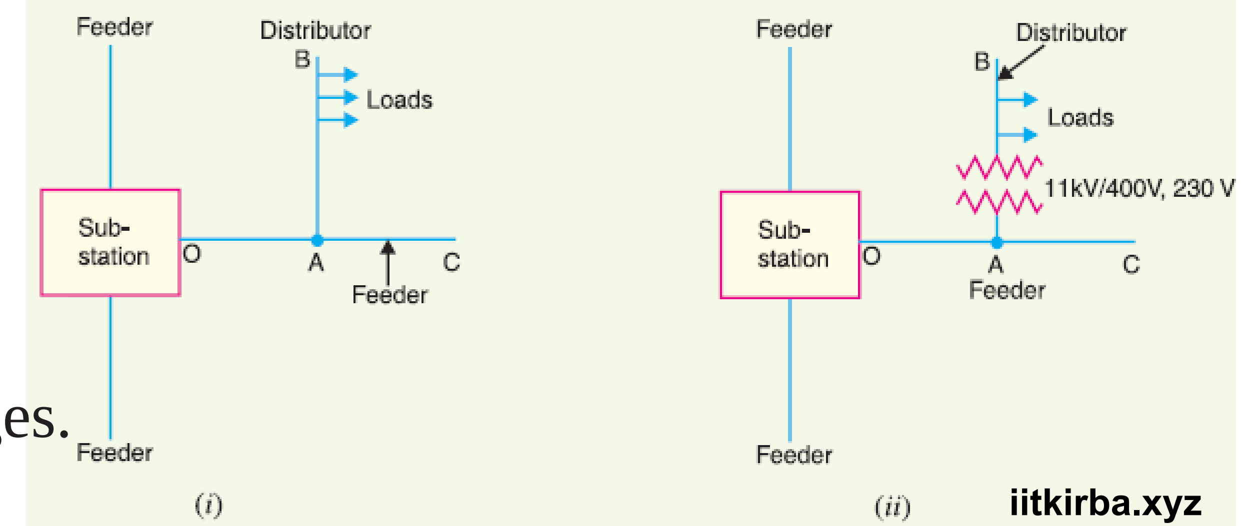


Fig. 12.8

(*ii*) Ring main system

In this system, the primaries of distribution transformers form a loop. The loop circuit starts from the substation bus-bars, makes a loop through the area to be served, and returns to the substation. Fig. 12.9 shows the single line diagram of ring main system for a.c. distribution where substation supplies to the closed feeder LMNOPQRS. The distributors are tapped from different points *M*, *O* and *Q* of the feeder through distribution transformers.

Advantages :

(*a*) There are less voltage fluctuations at consumer's terminals.

(*b*) The system is very reliable as each distributor is fed *via* two feeders. In the event of fault on any section of the feeder, the continuity of supply is maintained.

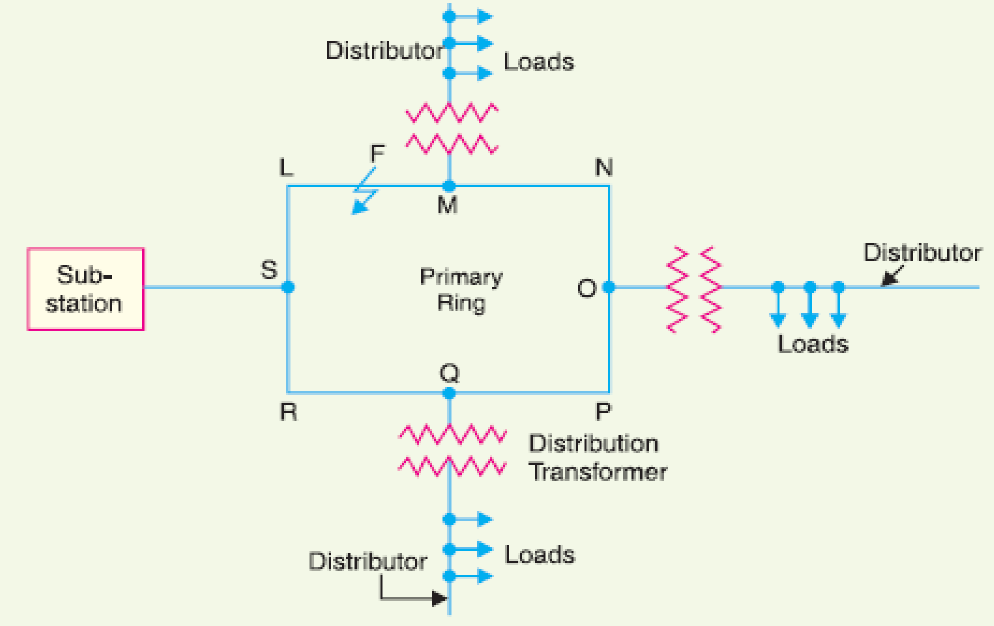


Fig. 12.9

(*iii*) Interconnected system

When the feeder ring is energised by two or more than two generating stations or substations, it is called inter-connected system. Fig. 12.10 shows the single line diagram of interconnected system where the closed feeder ring *ABCD* is supplied by two substations *S*1 and *S*2 at points *D* and *C* respectively. Distributors are connected to points *O*, *P*, *Q* and *R* of the feeder ring through distribution transformers.

Advantages :

(***a***) It increases the service reliability.

(***b***) Any area fed from one generating station during peak load hours can be fed from the other generating station. This reduces reserve power capacity and increases efficiency of the system.

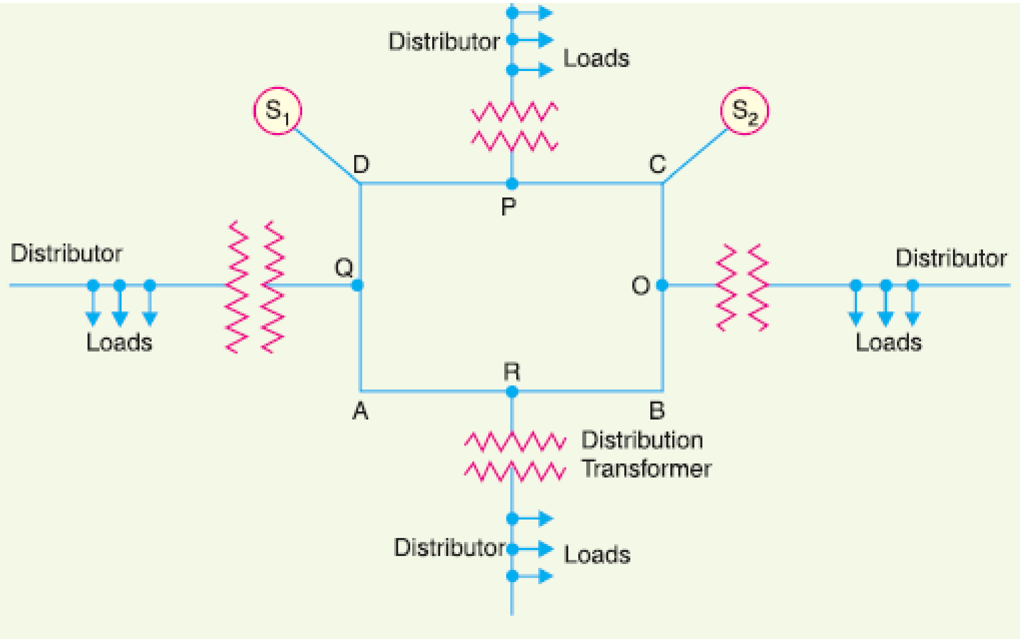


Fig. 12.10

Types of D.C. Distributors

The most general method of classifying d.c. distributors is the way they are fed by the feeders.

On this basis, d.c. distributors are classified as:

(*i*) Distributor fed at one end

(*ii*) Distributor fed at both ends

(*iii*) Distributor fed at the centre

(*iv*) Ring distributor.

(i) Distributor fed at one end.

In this type of feeding, the distributor is connected to the supply at one end and loads are taken at different points along the length of the distributor. Fig. 13.1 shows the single line diagram of a d.c. distributor *AB* fed at the end *A* (also known as *singly fed distributor*) and loads *I*1, *I*2 and *I*3 tapped off at points *C*, *D* and *E* respectively.

The following points are worth noting in a singly fed distributor :

(a) The current in the various sections of the distributor away from feeding point goes on decreasing. Thus current in section *AC* is more than the current in section *CD* and current in section *CD* is more than the current in section *DE*.

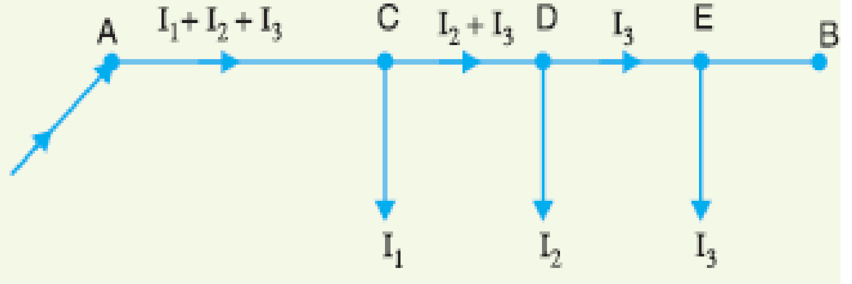


Fig. 13.1

(*b*) The voltage across the loads away from the feeding point goes on decreasing. Thus in Fig. 13.1, the minimum voltage occurs at the load point *E*.

(*c*) In case a fault occurs on any section of the distributor, the whole distributor will have to be disconnected from the supply mains. Therefore, continuity of supply is interrupted.

(*ii*) Distributor fed at both ends. In this type of feeding, the distributor is connected to the supply mains at both ends and loads are tapped off at different points along the length of the distributor. The voltage at the feeding points may or may not be equal. Fig. 13.2 shows a distributor *AB* fed at the ends *A* and *B* and loads of *I*1, *I*2 and *I*3 tapped off at points *C*, *D* and *E* respectively. Here, the load voltage goes on decreasing as we move away from one feeding point *say A*, reaches minimum value and then again starts rising and reaches maximum value when we reach the other feeding point *B*. The minimum voltage occurs at some load point and is never fixed. It is shifted with the variation of load on different sections of the distributor.

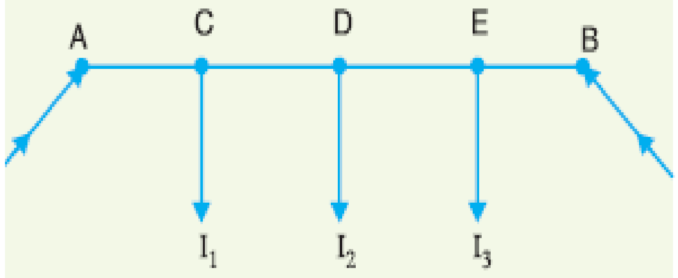


Fig. 13.2

Advantages

(*a*) If a fault occurs on any feeding point of the distributor, the continuity of supply is maintained from the other feeding point.

(*b*) In case of fault on any section of the distributor, the continuity of supply is maintained from the other feeding point.

(*c*) The area of X-section required for a doubly fed distributor is much less than that of a singly fed distributor.

(*iii*) Distributor fed at the centre. In this type of feeding, the centre of the distributor is connected to the supply mains as shown in Fig. 13.3. It is equivalent to two singly fed distributors, each distributor having a common feeding point and length equal to half of the total length.

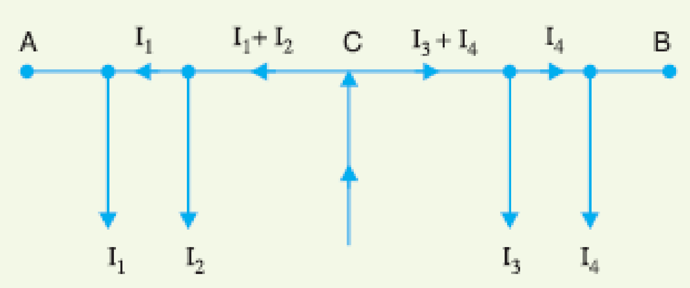


Fig. 13.3

(*iv*) Ring mains. In this type, the distributor is in the form of a closed ring as shown in Fig.13.4. It is equivalent to a straight distributor fed at both ends with equal voltages, the two ends being brought together to form a closed ring. The distributor ring may be fed at one or more than one point.

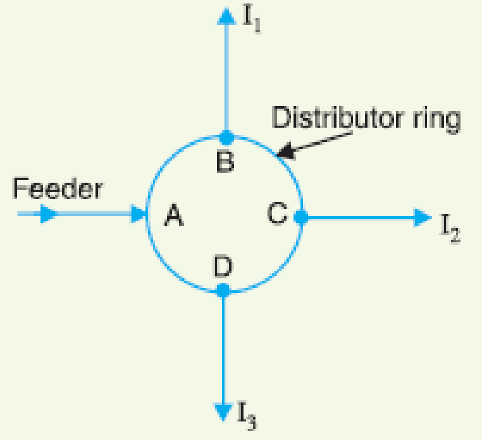


Fig. 13.4

Voltage Drop and Load Calculation for Concentrated and Distributed Loads,

A distributor may have

(*i*) Concentrated loading

(*ii*) Uniform loading

(*iii*) Both concentrated and uniform loading.

- ➢ The concentrated loads are those which act on particular points of the distributor.
- ❖ A common example of such loads is that tapped off for domestic use.
- ➢ On the other hand, distributed loads are those which act uniformly on all points of the distributor. Ideally, there are no distributed loads.
- ❖ However, a nearest example of distributed load is a large number of loads of same wattage connected to the distributor at equal distances.

In d.c. distribution calculations, one important point of interest is the determination of point of minimum potential on the distributor. The point where it occurs depends upon the loading conditions and the method of feeding the distributor. The distributor is so designed that the minimum potential on it is not less than 6% of rated voltage at the consumer's terminals

- ✓ D.C. Distributor Fed at one End—Concentrated Loading
- ✓ Uniformly Loaded Distributor Fed at One End
- ✓ Distributor Fed at Both Ends — Concentrated Loading
- ✓ Uniformly Loaded Distributor Fed at Both Ends
- ✓ Distributor with Both Concentrated and Uniform Loading
- ✓ Ring Distributor
- ✓ Ring Main Distributor with Interconnector

✓ D.C. Distributor Fed at one End—Concentrated Loading

Fig. 13.5 shows the single line diagram of a 2-wire d.c. distributor *AB* fed at one end *A* and having concentrated loads $I1$, $I2$, $I3$ and $I4$ tapped off at points *C*, *D*, *E* and *F* respectively.

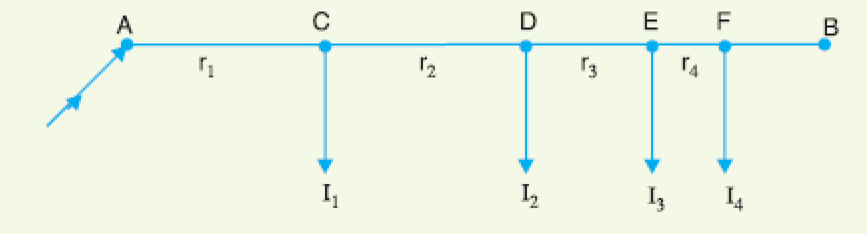


Fig. 13.5

Let $r1$, $r2$, $r3$ and $r4$ be the resistances of both wires (go and return) of the sections *AC*, *CD*, *DE* and *EF* of the distributor respectively.

Current fed from point $A = I1 + I2 + I3 + I4$

Current in section $AC = I1 + I2 + I3 + I4$

Current in section $CD = I2 + I3 + I4$

Current in section $DE = I3 + I4$

Current in section $EF = I4$

Voltage drop in section $AC = r1\ (I1 + I2 + I3 + I4)$

Voltage drop in section $CD = r2\ (I2 + I3 + I4)$

Voltage drop in section $DE = r3\ (I3 + I4)$

Voltage drop in section $EF = r4\ I4$

Total voltage drop in the distributor

$= r1\ (I1 + I2 + I3 + I4) + r2\ (I2 + I3 + I4) + r3\ (I3 + I4) + r4\ I4$

It is easy to see that the minimum potential will occur at point *F* which is farthest from the feeding point *A*.

Fig 13.11 shows the single line diagram of a 2-wire d.c. distributor *AB* fed at one end *A* and loaded uniformly with *i* amperes per metre length. It means that at every 1 m length of the distributor, the load tapped is *i* amperes. Let *l* metres be the length of the distributor and *r* ohm be the resistance per metre run.

Consider a point *C* on the distributor at a distance *x* metres from the feeding point *A* as shown in Fig. 13.12.

Then current at point *C* is $= il - ix \; amperes = i(l-x) amperes$

Now, consider a small length *dx* near point *C*. Its resistance is *r dx* and the voltage drop over length *dx* is $dV = i(l-x)r\,dx = ir(l-x)dx$

Total voltage drop in the distributor upto point *C* is

$$V = \int_0^x ir(l-x)dx = ir\left(lx - \frac{x^2}{2}\right)$$

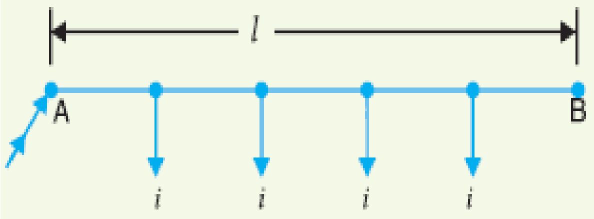


Fig. 13.11

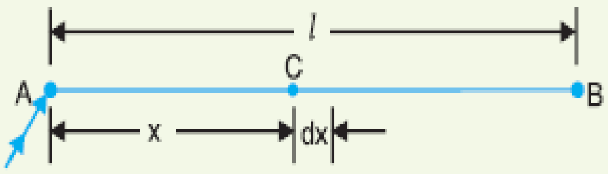


Fig. 13.12

The voltage drop upto point *B* (*i.e.* over the whole distributor) can be obtained by putting $x = l$ in the above expression.

Voltage drop over the distributor $AB = ir\left(l \times l - \frac{l^2}{2}\right)$

$$= \frac{1}{2} irl^2 = \frac{1}{2}(il)(rl)$$

$$= \frac{1}{2} IR$$

$i\,l = I$, the total current entering at point *A*

$r\,l = R$, the total resistance of the distributor

Thus, in a uniformly loaded distributor fed at one end, the total voltage drop is equal to that produced by the whole of the load assumed to be concentrated at the middle point.

Distributor Fed at Both Ends — Concentrated Loading

Whenever possible, it is desirable that a long distributor should be fed at both ends instead of at one end only, since total voltage drop can be considerably reduced without increasing the cross-section of the conductor. The two ends of the distributor may be supplied with

(*i*) equal voltages **(*ii*)** unequal voltages.

(*i*) Two ends fed with equal voltages. Consider a distributor *AB* fed at both ends with equal voltages *V* volts and having concentrated loads *I*1, *I*2, *I*3, *I*4 and *I*5 at points *C*, *D*, *E*, *F* and *G* respectively as shown in Fig. 13.14. As we move away from one of the feeding points, *say A*, p.d. goes on decreasing till it reaches the minimum value at some load point, *say E*, and then again starts rising and becomes *V* volts as we reach the other feeding point *B*.

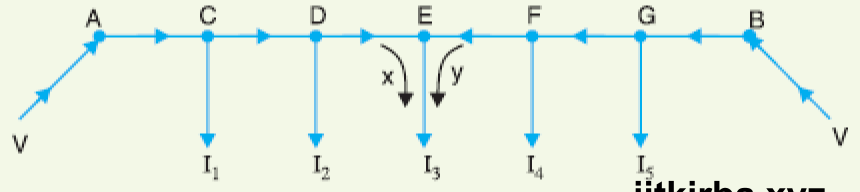


Fig. 13.14

All the currents tapped off between points *A* and *E* (minimum p.d. point) will be supplied from the feeding point *A* while those tapped off between *B* and *E* will be supplied from the feeding point *B*. The current tapped off at point *E* itself will be partly supplied from *A* and partly from *B*. If these currents are *x* and *y* respectively, then,

$I_3 = x + y$

Therefore, we arrive at a very important conclusion that at the point of minimum potential, current comes from both ends of the distributor.

Point of minimum potential. It is generally desired to locate the point of minimum potential. There is a simple method for it. Consider a distributor *AB* having three concentrated loads *I*1, *I*2 and *I*3 at points *C*, *D* and *E* respectively. Suppose that current supplied by feeding end *A* is *IA*. Then current distribution in the various sections of the distributor can be worked out as shown in Fig. 13.15

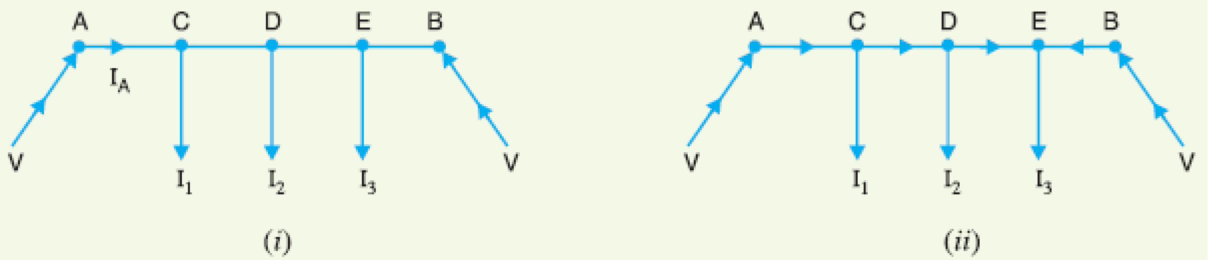


Fig. 13.15

Thus

$I_{AC} = I_A$; $ICD = I_A - I_1$

$I_{DE} = I_A - I_1 - I_2$; $I_{EB} = I_A - I_1 - I_2 - I_3$

Voltage drop between *A* and *B* = Voltage drop over *AB*

or $V - V = I_A R_{AC} + (I_A - I_1) R_{CD} + (I_A - I_1 - I_2) R_{DE} + (I_A - I_1 - I_2 - I_3) R_{EB}$

From this equation, the unknown I_A can be calculated as the values of other quantities are generally given. Suppose *actual* directions of currents in the various sections of the distributor are indicated as shown in Fig. 13.15 (*ii*). The load point where the currents are coming from both sides of the distributor is the point of minimum potential *i.e*. point *E* in this case

(*ii*) Two ends fed with unequal voltages. Fig. 13.16 shows the distributor *AB* fed with unequal voltages ; end *A* being fed at V_1 volts and end *B* at V_2 volts. The point of minimum potential can be found by following the same procedure as discussed above. Thus in this case, Voltage drop between *A* and *B* = Voltage drop over *AB*

or $V_1 - V_2$ = Voltage drop over *AB*

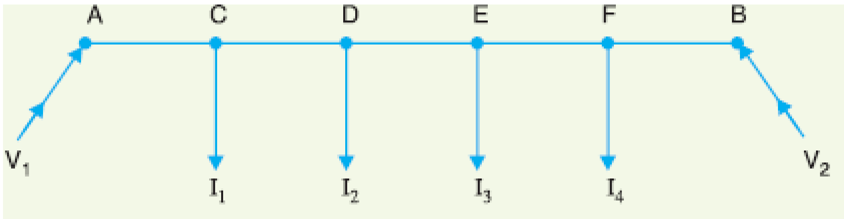


Fig. 13.16

Uniformly Loaded Distributor Fed at Both Ends

We shall now determine the voltage drop in a uniformly loaded distributor fed at both ends. There can be two cases *viz*. the distributor fed at both ends with (*i*) equal voltages (*ii*) unequal voltages. The two cases shall be discussed separately.

(*i*) Distributor fed at both ends with equal voltages. Consider a distributor *AB* of length *l* metres, having resistance *r* ohms per metre run and with uniform loading of *i* amperes per metre run as shown in Fig. 13.24. Let the distributor be fed at the feeding points *A* and *B* at equal voltages, say *V* volts. The total current supplied to the distributor is *i l*. As the two end voltages are equal, therefore, current supplied from each feeding point is *i l*/2 *i.e*. Current supplied from each feeding point $= \frac{il}{2}$

Consider a point C at a distance x metres from the feeding point A. Then current at point C is

$$= \frac{il}{2} - ix = i\left(\frac{l}{2} - x\right)$$

Now, consider a small length dx near point C. Its resistance is $r\,dx$ and the voltage drop over length dx is

$$dV = i\left(\frac{l}{2} - x\right) r\,dx = ir\left(\frac{l}{2} - x\right)dx$$

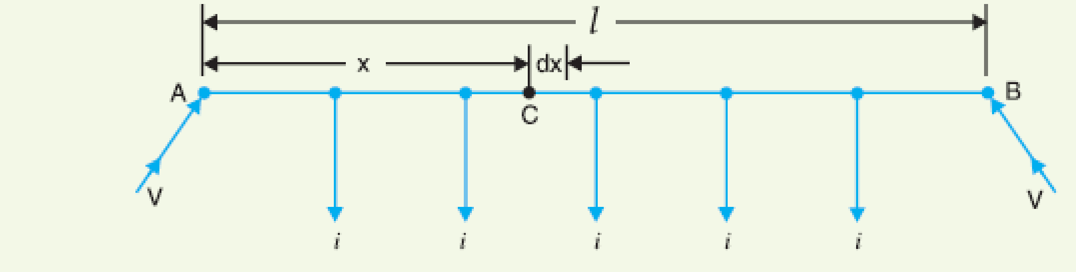


Fig. 13.24

Voltage drop upto point C $= \int_0^x ir\left(\frac{l}{2} - x\right)dx = ir\left(\frac{lx}{2} - \frac{x^2}{2}\right)$

$$= \frac{ir}{2}\left(lx - x^2\right)$$

Obviously, the point of minimum potential will be the mid-point. Therefore, maximum voltage drop will occur at mid-point *i.e.* where $x = l/2$.

Max. voltage drop $= \frac{ir}{2}\left(lx - x^2\right)$

$$= \frac{ir}{2}\left(l\frac{l}{2} - \frac{l^2}{4}\right)$$

$$= \frac{1}{8}irl^2 = \frac{1}{8}IR$$

$i\,l = I$, the total current fed to the distributor from both ends

$r\,l = R$, the total resistance of the distributor

Minimum voltage $= V - \frac{IR}{8}\,volts$

(*ii*) Distributor fed at both ends with unequal voltages. Consider a distributor *AB* of length *l* metres having resistance *r* ohms per metre run and with a uniform loading of *i* amperes per metre run as shown in Fig. 13.25. Let the distributor be fed from feeding points *A* and *B* at voltages *VA* and *VB* respectively.

Suppose that the point of minimum potential *C* is situated at a distance *x* metres from the feeding point *A*. Then current supplied by the feeding point *A* will be **i x*.

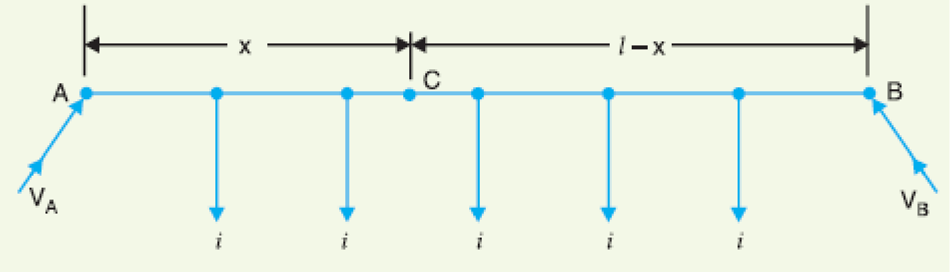


Fig. 13.25

Voltage drop in section $AC = \frac{irx^2}{2}\ volts$

As the distance of *C* from feeding point *B* is (*l* – *x*), therefore, current fed from *B* is *i* (*l* – *x*).

Voltage drop in section $BC = \frac{ir(l-x)^2}{2}\ volts$

Voltage at point *C*

$$V_C = V_A - Drop\ over\ AC$$

$$= V_A - \frac{irx^2}{2}$$

Also, voltage at point C, $V_C = V_B -$ Drop over BC

$$V_B - \frac{ir(l-x)^2}{2}$$

$$V_A - \frac{irx^2}{2} = V_B - \frac{ir(l-x)^2}{2}$$

$$x = \frac{V_A - V_B}{irl} + \frac{l}{2}$$

As all the quantities on the right hand side of the equation are known, therefore, the point on the distributor where minimum potential occurs can be calculated.

Distributor with Both Concentrated and Uniform Loading

There are several problems where a distributor has both concentrated and uniform loadings. In such situations, the total drop over any section of the distributor is equal to the sum of drops due to concentrated and uniform loading in that section. We shall solve a few problems by way of illustration

Ring Distributor

- A distributor arranged to form a closed loop and fed at one or more points is called a *ring distributor.*
- Such a distributor starts from one point, makes a loop through the area to be served, and returns to the original point.
- For the purpose of calculating voltage distribution, the distributor can be considered as consisting of a series of open distributors fed at both ends.
- Advantage of ring distributor - that by proper choice in the number of feeding points, great economy in copper can be affected.

Ring Main Distributor with Interconnector

Sometimes a ring distributor has to serve a large area. In such a case, voltage drops in the various sections of the distributor may become excessive. In order to reduce voltage drops in various sections, distant points of the distributor are joined through a conductor called *interconnector*. Fig. 13.38 shows the ring distributor *ABCDEA*. The points *B* and *D* of the ring distributor are joined through an interconnector *BD*. There are several methods for solving such a network. However, the solution of such a network can be readily obtained by applying Thevenin's theorem. The steps of procedure are :

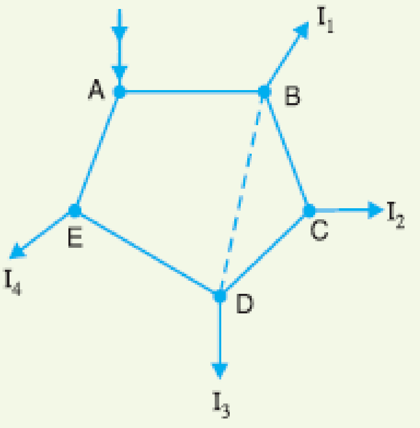


Fig. 13.38

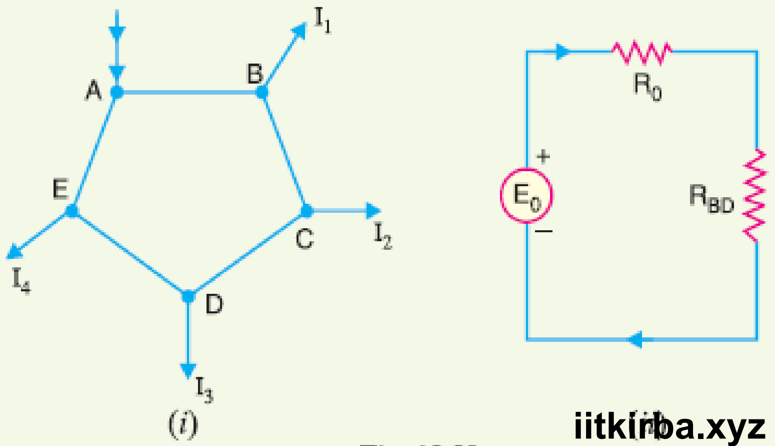


Fig. 13.39

(*i*) Consider the interconnector *BD* to be disconnected [See Fig. 13.39 (*i*)] and find the potential difference between *B* and *D*. This gives Thevenin's equivalent circuit voltage E_0.

(*ii*) Next, calculate the resistance viewed from points *B* and *D* of the network composed of distribution lines only. This gives Thevenin's equivalent circuit series resistance R_0.

(*iii*) If R_{BD} is the resistance of the interconnector *BD*, then Thevenin's equivalent circuit will be as shown in Fig. 13.39 (*ii*).

$$\text{Current in interconnector } BD = \frac{E_0}{R_0 + R_{BD}}$$

Primary and secondary distribution network

- Now-a-days electrical energy is generated, transmitted and distributed in the form of alternating current.
- One important reason for the widespread use of alternating current in preference to direct current is the fact that alternating voltage can be conveniently changed in magnitude by means of a transformer.
- Transformer has made it possible to transmit a.c. power at high voltage and utilise it at a safe potential. High transmission and distribution voltages have greatly reduced the current in the conductors and the resulting line losses.
- There is no definite line between transmission and distribution according to voltage or bulk capacity.
- However, in general, the a.c. distribution system is the electrical system between the stepdown substation fed by the transmission system and the consumers' meters.
- The a.c. distribution system is classified into
  - (*i*) primary distribution system
  - (*ii*) secondary distribution system.

(*i*) Primary distribution system.

It is that part of a.c. distribution system which operates at voltages somewhat higher than general utilisation and handles large blocks of electrical energy than the average low-voltage consumer uses. The voltage used for primary distribution depends upon the amount of power to be conveyed and the distance of the substation required to be fed. The most commonly used primary distribution voltages are *11 kV, 6·6 kV and 3·3* kV. Due to economic considerations, primary distribution is carried out by 3- phase, 3-wire system.

Fig. 12.2 shows a typical primary distribution system. Electric power from the generating station is transmitted at high voltage to the substation located in or near the city. At this substation, voltage is stepped down to 11 kV with the help of step-down transformer. Power is supplied to various substations for distribution or to big consumers at this voltage. This forms the high voltage distribution or primary distribution.

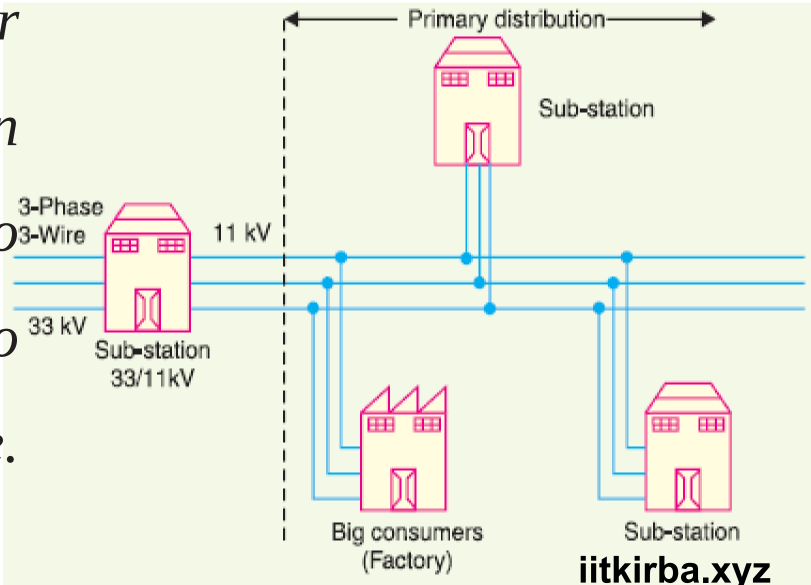


Fig. 12.2

(*ii*) Secondary distribution system.

- It is that part of a.c. distribution system which includes the range of voltages at which the ultimate consumer utilises the electrical energy delivered to him.
- The secondary distribution employs 400/230 V, 3-phase, 4-wire system. Fig. 12.3 shows a typical secondary distribution system.
- The primary distribution circuit delivers power to various substations, called distribution substations.
- The substations are situated near the consumers' localities and contain stepdown transformers.

- At each distribution substation, the voltage is stepped down to 400V and power is delivered by 3-phase,4-wire a.c. system.
- The voltage between any two phases is 400 V and between any phase and neutral is 230 V.
- The single phase domestic loads are connected between any one phase and the neutral, whereas 3-phase 400 V motor loads are connected across 3-phase lines directly

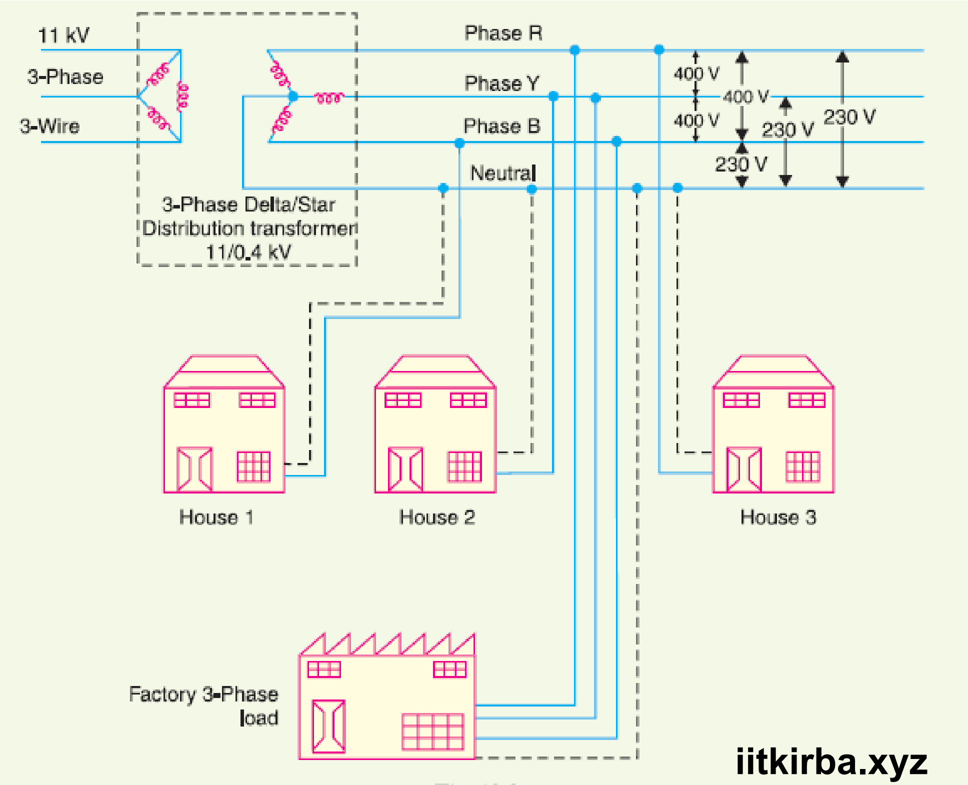


Fig. 12.3

Capacitor placement in distribution networks

Distribution system planning

All distribution of electrical energy is done by constant voltage system. In practice, the following distribution circuits are generally used :

(*i*) Radial System. In this system, separate feeders radiate from a single substation and feed the distributors at one end only. Fig. 12.8 (*i*) shows a single line diagram of a radial system for d.c. distribution where a feeder *OC* supplies a distributor *AB* at point *A*. Obviously, the distributor is fed at one end only *i.e.*, point *A* is this case. load.

Fig. 12.8 (*ii*) shows a single line diagram of radial system for a.c. distribution. The radial system is employed only when power is generated at low voltage and the substation is located at the centre of the load.

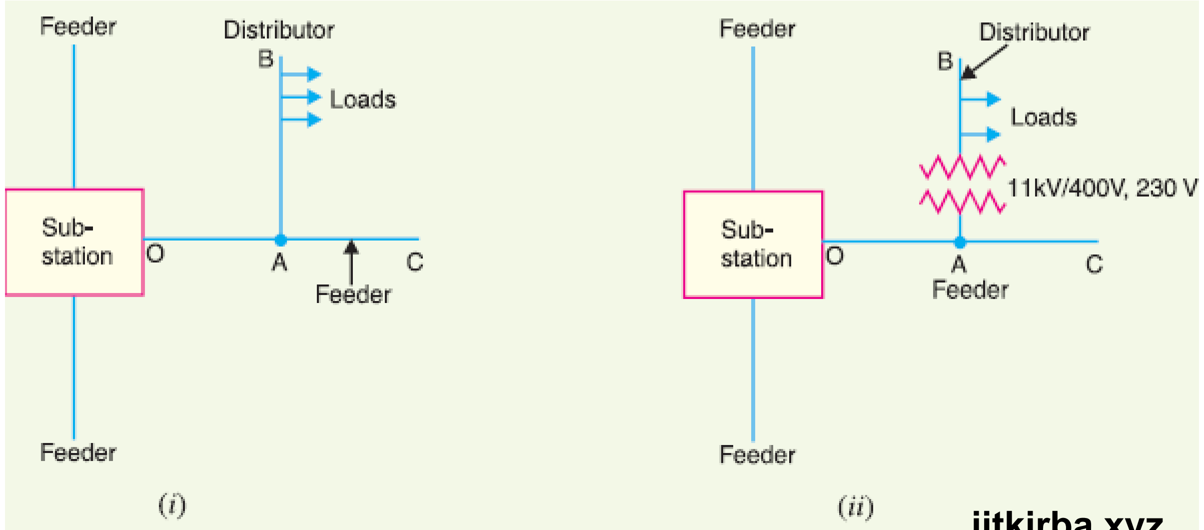


Fig. 12.8

This is the simplest distribution circuit and has the lowest initial cost.

Drawbacks :

(*a*) The end of the distributor nearest to the feeding point will be heavily loaded.

(*b*) The consumers are dependent on a single feeder and single distributor. Therefore, any fault on the feeder or distributor cuts off supply to the consumers who are on the side of the fault away from the substation.

(*c*) The consumers at the distant end of the distributor would be subjected to serious voltage fluctuations when the load on the distributor changes.

Due to these limitations, this system is used for short distances only.

(*ii*) Ring main system.

In this system, the primaries of distribution transformers form a loop.

The loop circuit starts from the substation bus-bars, makes a loop through the area to be served, and returns to the substation. Fig. 12.9 shows the single line diagram of ring main system for a.c. distribution where substation supplies to the closed feeder LMNOPQRS. The distributors are tapped from different points *M*, *O* and *Q* of the feeder through distribution transformers.

Advantages

(*a*) There are less voltage fluctuations at consumer's terminals.

(*b*) The system is very reliable as each distributor is fed *via* two feeders. In the event of fault on any section of the feeder, the continuity of supply is maintained.

For example, suppose that fault occurs at any point *F* of section SLM of the feeder. Then section SLM of the feeder can be isolated for repairs and at the same time continuity of supply is maintained to all the consumers *via* the feeder *SRQPONM*.

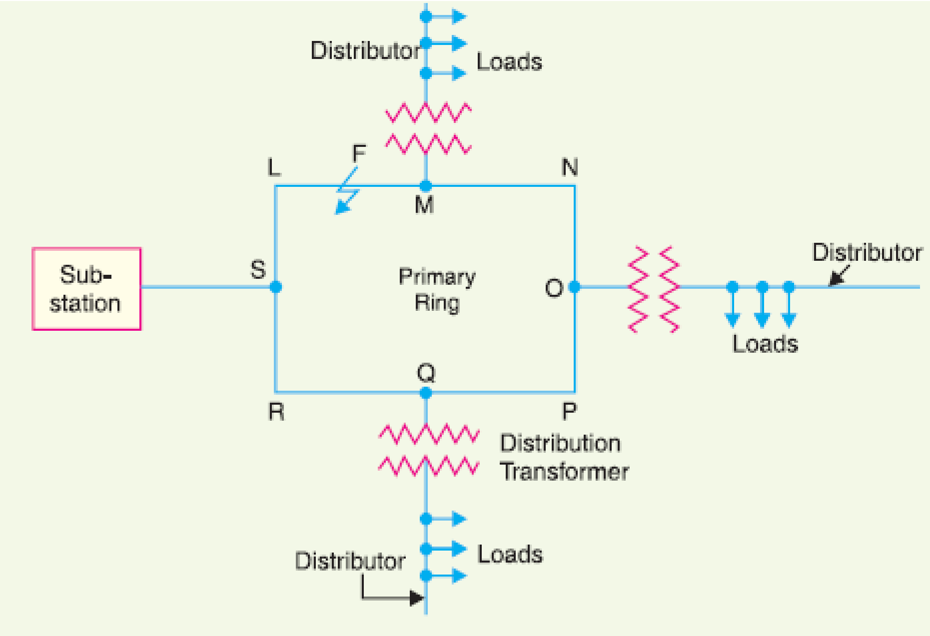


Fig. 12.9

(*iii*) Interconnected system. When the feeder ring is energised by two or more than two generating stations or substations, it is called inter-connected system. Fig. 12.10 shows the single line diagram of interconnected system where the closed feeder ring *ABCD* is supplied by two substations *S*1 and *S*2 at points *D* and *C* respectively. Distributors are connected to points *O*, *P*, *Q* and *R* of the feeder ring through distribution transformers.

Advantages :

(*a*) It increases the service reliability.

(*b*) Any area fed from one generating station during peak load hours can be fed from the other generating station. This reduces reserve power capacity and increases efficiency of the system.

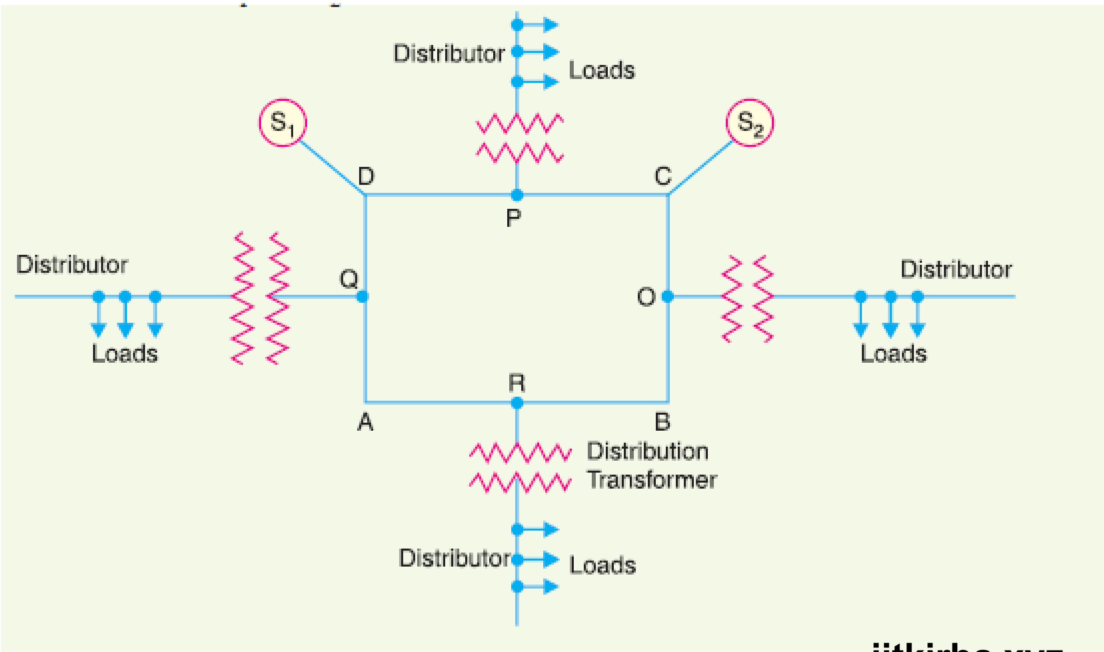


Fig. 12.10

Requirements of a Distribution System

A considerable amount of effort is necessary to maintain an electric power supply within the requirements of various types of consumers. Some of the requirements of a good distribution system are : proper voltage, availability of power on demand and reliability.

(*i*) Proper voltage. One important requirement of a distribution system is that voltage variations at consumer's terminals should be as low as possible. The changes in voltage are generally caused due to the variation of load on the system. Low voltage causes loss ofrevenue, inefficient lighting and possible burning out of motors. High voltage causes lamps

to burn out permanently and may cause failure of other appliances. Therefore, a good distribution system should ensure that the voltage variations at consumers terminals are within permissible limits. The statutory limit of voltage variations is ± 6% of the rated value at the consumer's terminals. Thus, if the declared voltage is 230 V, then the highest voltage of the consumer should not exceed 244 V while the lowest voltage of the consumer should not be less than 216 V.

(*ii*) Availability of power on demand. Power must be available to the consumers in any amount that they may require from time to time. For example, motors may be started or shut down, lights may be turned on or off, without advance warning to the electric supply company. As electrical energy cannot be stored, therefore, the distribution system must be capable of

supplying load demands of the consumers. This necessitates that operating staff must continuously study load patterns to predict in advance those major load changes that follow the known schedules.

(*iii*) Reliability. Modern industry is almost dependent on electric power for its operation. Homes and office buildings are lighted, heated, cooled and ventilated by electric power. This calls for reliable service. Unfortunately, electric power, like everything else that is man-made, can never be absolutely reliable. However, the reliability can be improved to a considerable

extent by (*a*) interconnected system (*b*) reliable automatic control system (*c*) providing additional

reserve facilities.

Design Considerations in Distribution System

Good voltage regulation of a distribution network is probably the most important factor responsible for delivering good service to the consumers. For this purpose, design of feeders and distributors requires careful consideration.

(*i*) *Feeders.* A feeder is designed from the point of view of its current carrying capacity while the voltage drop consideration is relatively unimportant. It is because voltage drop in a feeder can be compensated by means of voltage regulating equipment at the substation.

(*ii*) *Distributors.* A distributor is designed from the point of view of the voltage drop in it. It is because a distributor supplies power to the consumers and there is a statutory limit of voltage variations at the consumer's terminals (± 6% of rated value). The size and length of the distributor should be such that voltage at the consumer's terminals is within the permissible limits.

Service area calculation