كلية المأمون الجامعة

قسم هندسة تقنيات القدرة الكهربائية

المرحلة الرابعة

D.C. Distribution

أنظمة النقل والتوزيع

محاضرة رقم (8)

At the end of 19th century, when Edison built the first electrical distribution networks, they were based on DC technology. However, with the invention of transformers, AC system proved to be much more superior to DC system at that time and AC systems were universally adopted for power generation, transmission as well as distribution.

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:

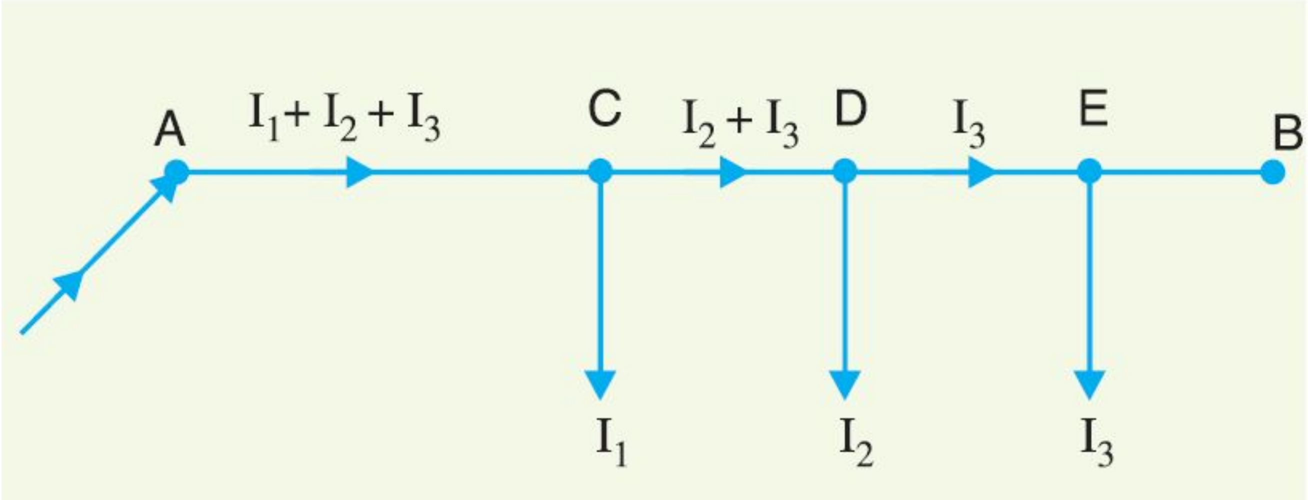
(i) Distributor fed at one end

(ii) Distributor fed at both ends

(iii) Distributor fed at the centre

(iv) Ring distributor.

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.

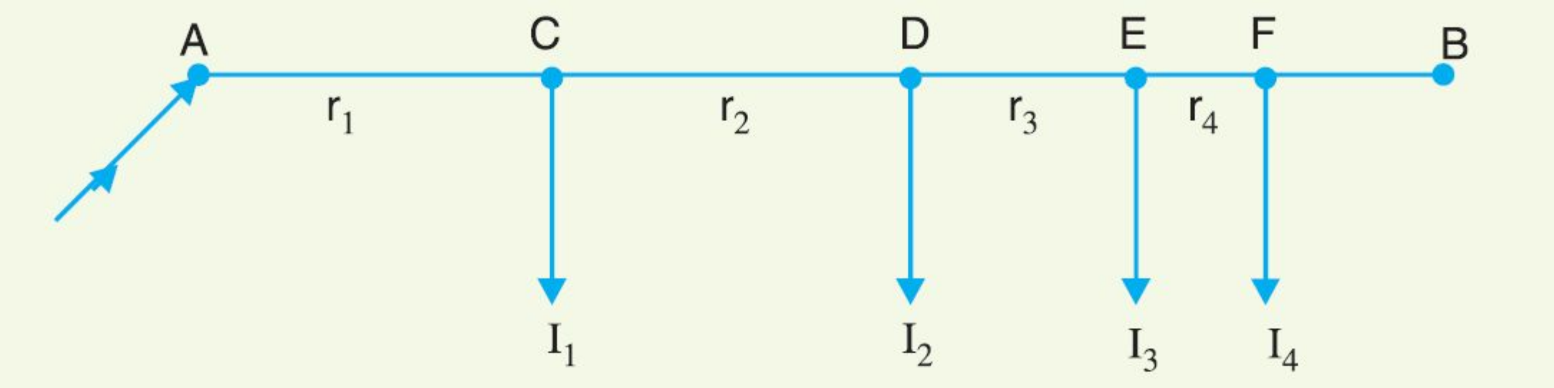


The following points are worth noting in a singly fed distributor :

(*a*) The current in the various sections of the distributor away from feeding point goes on decreasing.

(*b*) The voltage across the loads away from the feeding point goes on decreasing.

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



Current fed from point A $= I_1 + I_2 + I_3 + I_4$

Current in section AC $= I_1 + I_2 + I_3 + I_4$

Current in section CD $= I_2 + I_3 + I_4$

Current in section DE $= I_3 + I_4$

Current in section EF $= I_4$

Voltage drop in section AC $= r_1 (I_1 + I_2 + I_3 + I_4)$

Voltage drop in section CD $= r_2 (I_2 + I_3 + I_4)$

Voltage drop in section DE $= r_3 (I_3 + I_4)$

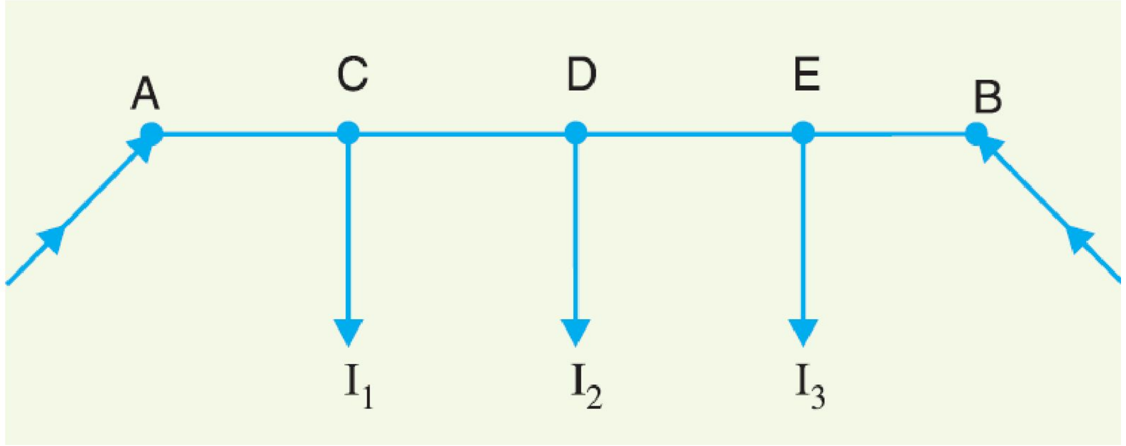
Voltage drop in section EF $= r_4 I_4$

∴ Total voltage drop in the distributor

$$= r_1 (I_1 + I_2 + I_3 + I_4) + r_2 (I_2 + I_3 + I_4) + r_3 (I_3 + I_4) + r_4 I_4$$

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

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.



Advantages

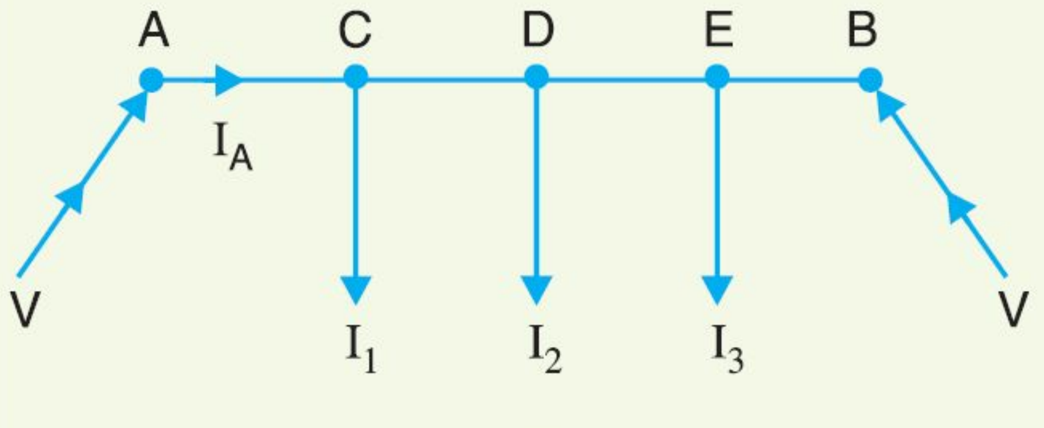
(*a*) If a fault occurs on any feeding point of the distributor, the continuity of supply is maintained from the other feeding point.

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

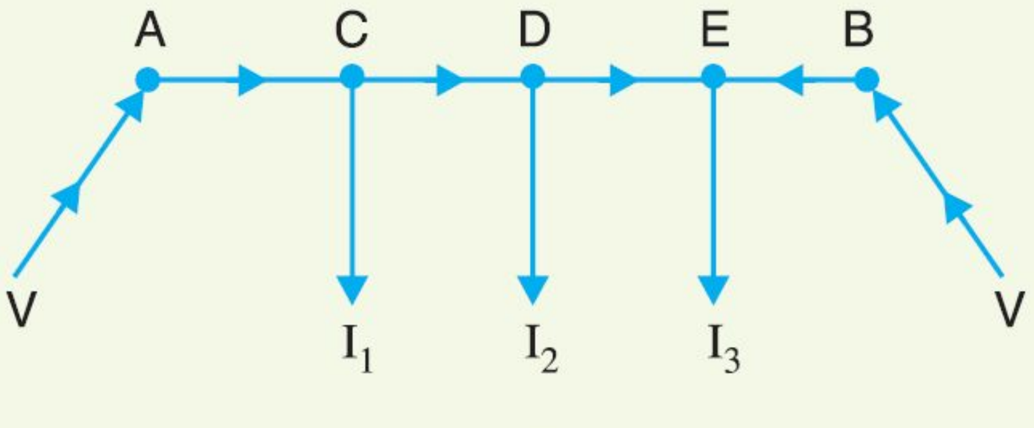
(c) The area of X-section required for a doubly fed distributor is much less than that of a singly fed distributor.

$$I_{AC} = I_A \; ; \qquad I_{CD} = I_A - I_1$$

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



(*i*)

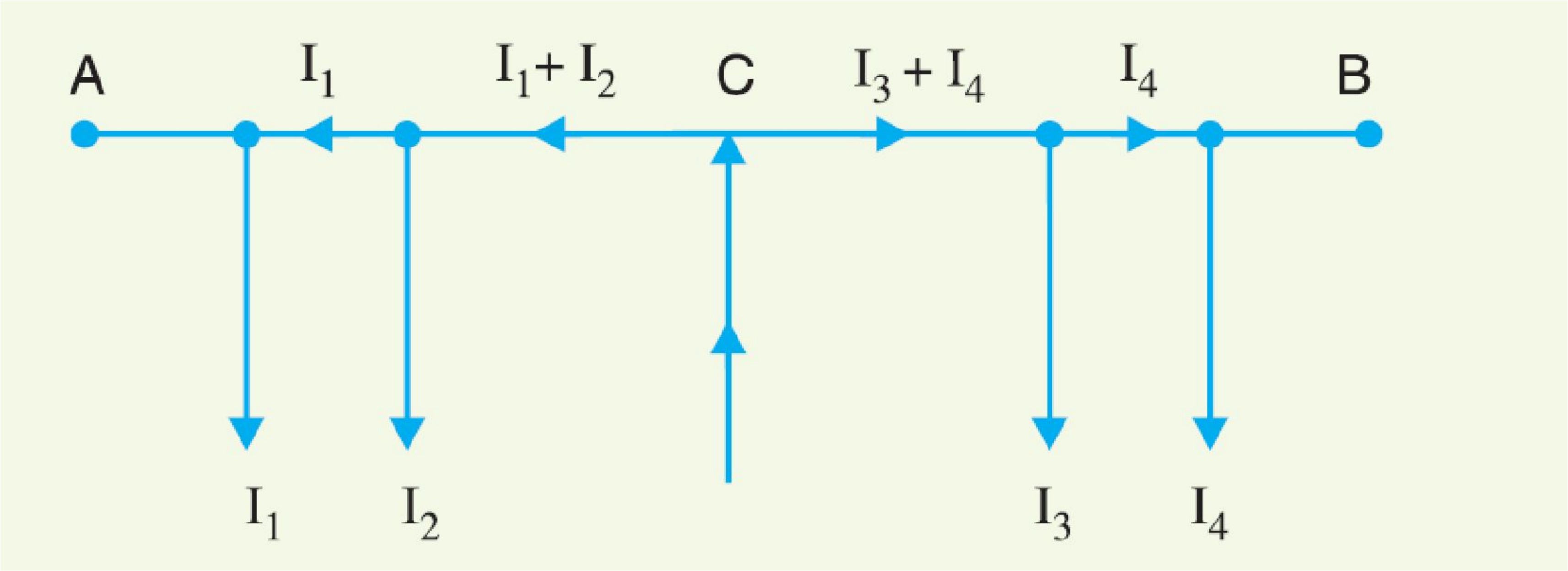


(*ii*)

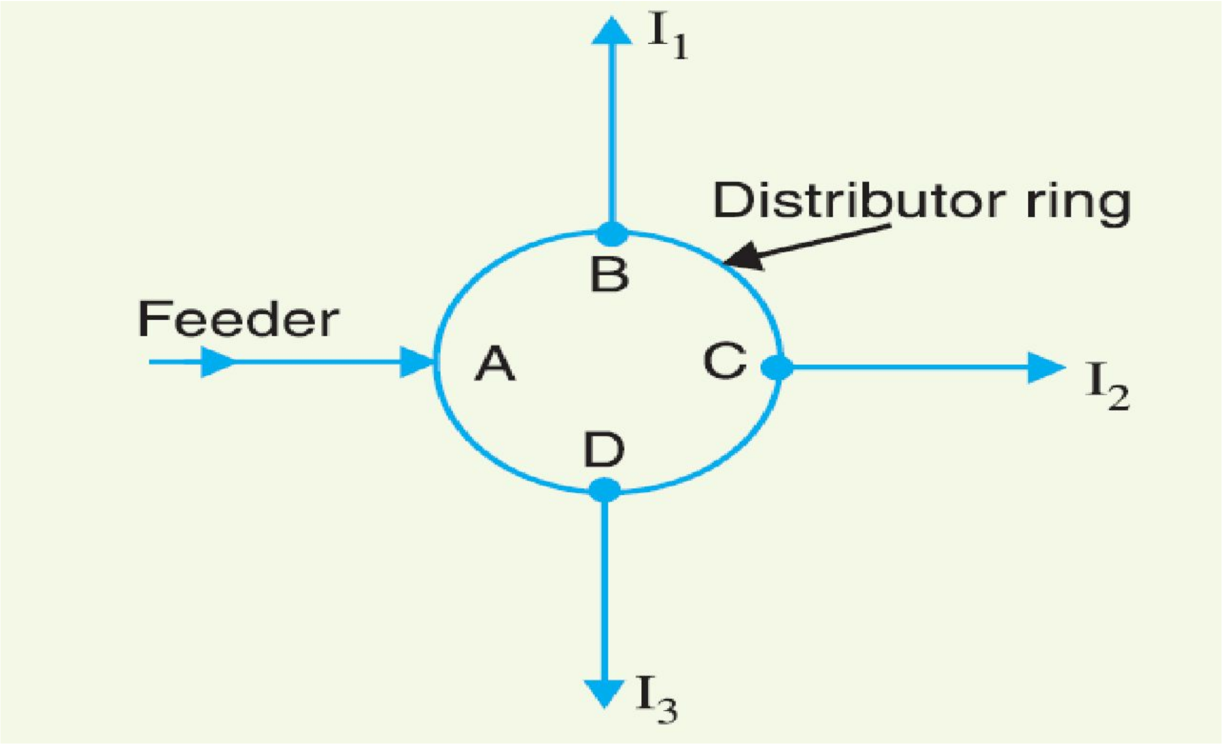
Voltage drop between A and B = Voltage drop over AB

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

Distributor fed at the centre. the distributor is supplied at the center point. Voltage drop at the farthest ends is not as large as that would be in a distributor fed at one end. each distributor having a common feeding point and length equal to half of the total length.



Ring mains. In this type, the distributor is in the form of a closed ring. 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.



Example 13.4. *The load distribution on a two-wire d.c. distributor is shown in Fig. 13.9. The cross-sectional area of each conductor is 0·27 cm². The end A is supplied at 250 V. Resistivity of the wire is $\rho = 1{\cdot}78\ \mu\ \Omega$ cm. Calculate (i) the current in each section of the conductor (ii) the two-core resistance of each section (iii) the voltage at each tapping point.*

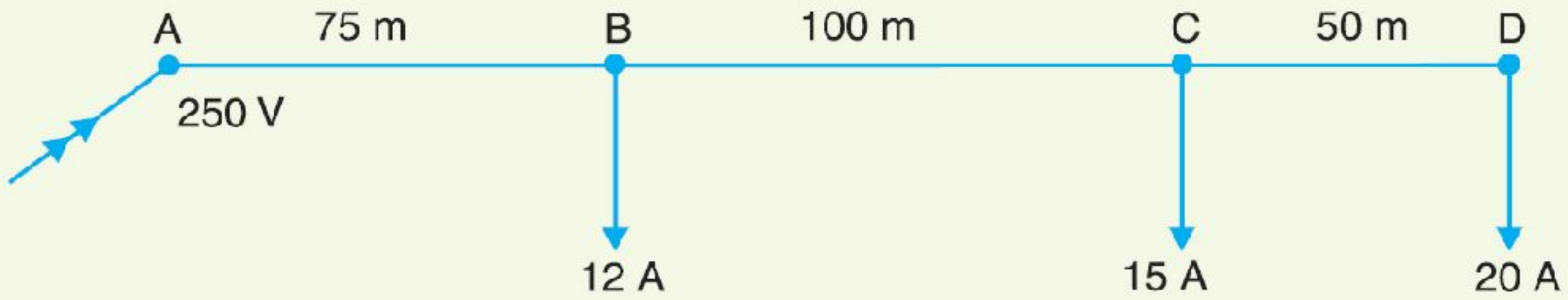


Fig. 13.9

Solution.

(*i*) Currents in the various sections are :

$$\text{Section } CD, I_{CD} = \textbf{20 A} \text{ ; section } BC, I_{BC} = 20 + 15 = \textbf{35 A}$$

$$\text{Section } AB, I_{AB} = 20 + 15 + 12 = \textbf{47 A}$$

(*ii*) Single-core resistance of the section of 100 m length

$$= \rho \frac{l}{a} = 1{\cdot}78 \times 10^{-6} \times \frac{100 \times 100}{0 \cdot 27} = 0{\cdot}066\ \Omega$$

The resistances of the various sections are :

$$R_{AB} = 0{\cdot}066 \times 0{\cdot}75 \times 2 = \mathbf{0{\cdot}099\ \Omega}\ ;\ R_{BC} = 0{\cdot}066 \times 2 = \mathbf{0{\cdot}132\ \Omega}$$

$$R_{CD} = 0{\cdot}066 \times 0{\cdot}5 \times 2 = \mathbf{0{\cdot}066\ \Omega}$$

(*iii*) Voltage at tapping point B is

$$V_B = V_A - I_{AB}\,R_{AB} = 250 - 47 \times 0{\cdot}099 = \mathbf{245{\cdot}35\ V}$$

Voltage at tapping point C is

$$V_C = V_B - I_{BC}\,R_{BC} = 245{\cdot}35 - 35 \times 0{\cdot}132 = \mathbf{240{\cdot}73\ V}$$

Voltage at tapping point D is

$$V_D = V_C - I_{CD}\,R_{CD} = 240{\cdot}73 - 20 \times 0{\cdot}066 = \mathbf{239{\cdot}41\ V}$$

Example 13.2. *A 2-wire d.c. distributor AB is 300 metres long. It is fed at point A. The various loads and their positions are given below :*

At point	*distance from A in metres*	*concentrated load in amperes*
C	*40*	*30*
D	*100*	*40*
E	*150*	*100*
F	*250*	*50*

If the maximum permissible voltage drop is not to exceed 10 V, find the cross-sectional area of the distributor. Take $\rho = 1{\cdot}78 \times 10^{-8}\ \Omega m$.

Fig. 13.7. Suppose that resistance of 100 m length of the distributor is r ohms. Then resistance of various sections of the distributor is :

$$R_{AC} = 0{\cdot}4\,r\,\Omega \quad ; \quad R_{CD} = 0{\cdot}6\,r\,\Omega \quad ; \quad R_{DE} = 0{\cdot}5\,r\,\Omega \quad ; \quad R_{EF} = r\,\Omega$$

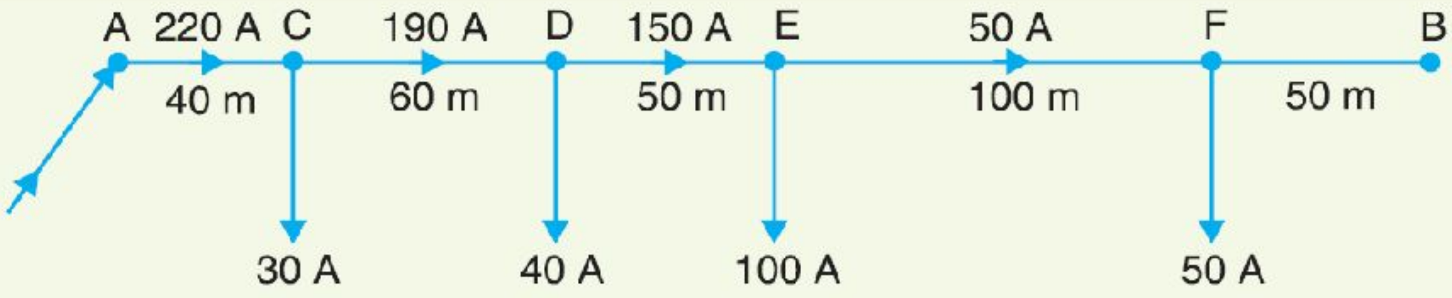


Fig. 13.7

Referring to Fig. 13.7, the currents in the various sections of the distributor are :

$$I_{AC} = 220\text{ A} \quad ; \quad I_{CD} = 190\text{ A} \quad ; \quad I_{DE} = 150\text{ A} \quad ; \quad I_{EF} = 50\text{ A}$$

Total voltage drop over the distributor

$$= I_{AC}R_{AC} + I_{CD}R_{CD} + I_{DE}R_{DE} + I_{EF}R_{EF}$$

$$= 220 \times 0{\cdot}4r + 190 \times 0{\cdot}6r + 150 \times 0{\cdot}5r + 50 \times r$$

$$327\,r$$

As the maximum permissible drop in the distributor is 10 V,

$$\therefore \quad 10 = 327\,r \quad \text{or} \quad r = 10/327 = 0{\cdot}03058\ \Omega$$

X-sectional area of conductor $\dfrac{*\rho l}{r/2} = \dfrac{1{\cdot}78 \times 10^{-8} \times 100}{\dfrac{0{\cdot}03058}{2}}$ $116{\cdot}4 \times 10^{-6}\ \text{m}^2$ $\mathbf{1{\cdot}164\ cm^2}$