1.10 Types of Sources

There are two types of sources: (i) ideal voltage source and (ii) ideal current source.

1.10.1 Ideal Voltage Source

It is that voltage source whose output voltage remains absolutely constant whatever the change in load current. It has zero internal resistance. In practice, ideal voltage source is not available, and every voltage source has some internal resistance. Smaller the resistance of a voltage source, more it will approach to the ideal voltage source. The ideal voltage source can be represented by either of the symbols shown in Fig. 1.85.

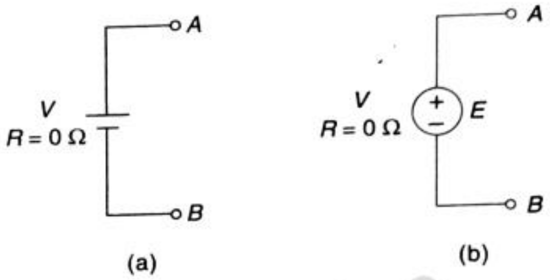

Fig. 1.85 Voltage source symbol

1.10.2 Ideal Current Source

It is that current source whose output current remains absolutely constant whatever the change in load resistance. Its internal resistance is infinity. At any load resistance, it supplies the constant current. In practice, ideal current source has very high resistance. Higher the resistance of a current source, more it will approach to the ideal source. The ideal current source can be represented by the symbol shown in Fig. 1.86.

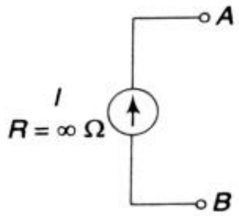

Fig. 1.86 Current source symbol

1.11 Source Transformation

The following points may be noted about a source transformation:

Case (i) A voltage source with a series resistance can be converted into (or replaced by) an equivalent current source with parallel resistance (Fig. 1.87).

Example It may be noted that if the polarity of a voltage source changes, accordingly the direction of the equivalent current source also changes (Fig. 1.88).

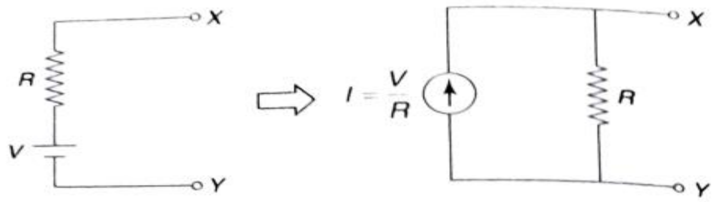

Fig. 1.87 Source transformation (voltage source to current source)

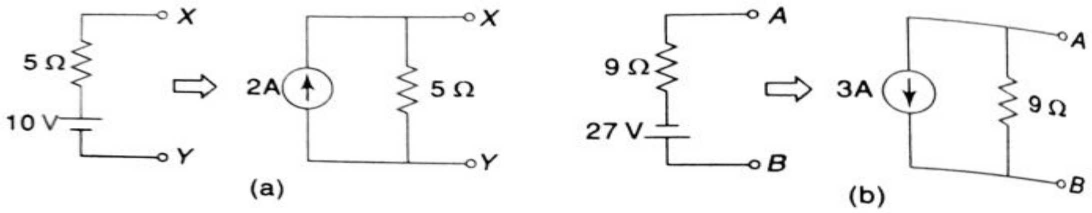

Fig. 1.88 Direction of equivalent current source

Case (ii) A current source with a parallel resistance can be converted into (or replaced by) an equivalent voltage source with series resistance as shown below:

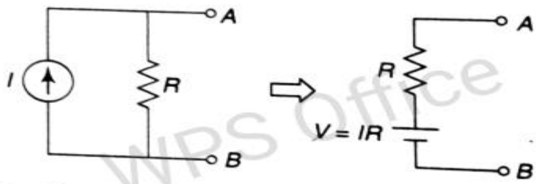

Fig. 1.89 Source transformation (current source to voltage source)

Example It may be noted that if the direction of a current source changes, accordingly the polarity of the equivalent voltage source also changes (Fig. 1.90).

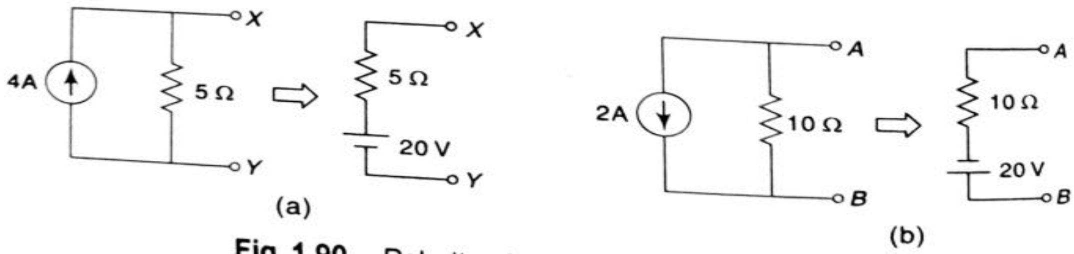

Fig. 1.90 Polarity of equivalent voltage source

Case (iii) Series voltage sources can be added.

Example In Fig. 1.91, voltage sources are connected in series with additive polarity. Resultant voltage source can be calculated directly by adding them and polarity of the resulted voltage source will be same as the given voltage sources.

Example In Fig. 1.92, voltage sources are connected in series with subtractive polarity. Resultant voltage source can be calculated by subtracting them (large

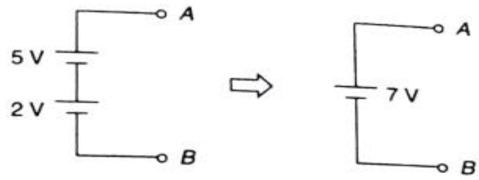

Fig. 1.91 Series voltage sources (aiding)

voltage source – small voltage source) and polarity of the resultant voltage source will be same as large voltage source.

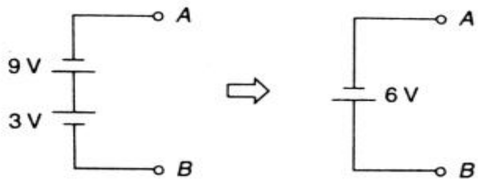

Fig. 1.92 Series voltage sources (opposing)

Case (iv) Parallel current sources can be added.

Example Current sources connected in parallel can be added or clubbed together. While clubbing the current sources, note their directions.

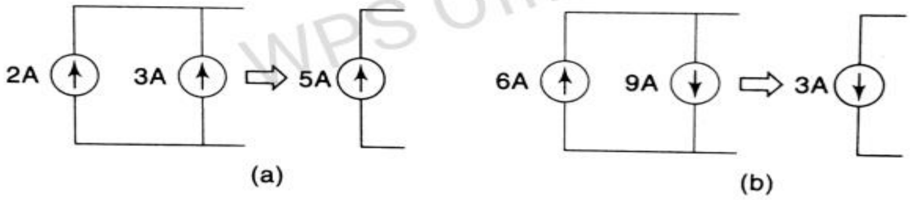

Fig. 1.93 Parallel current sources

Example 1.28 By source transformation, find current in 4 Ω resistor in a circuit of Fig. 1.94.

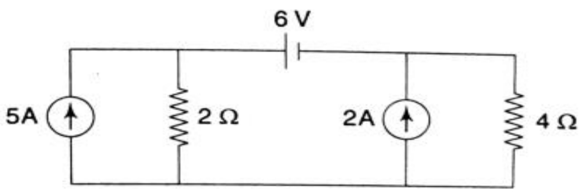

Fig. 1.94

Solution

Converting parallel combination of current source of 5 A and resistor of 2 Ω into equivalent series combination of voltage source and resistor, we get the following circuit:

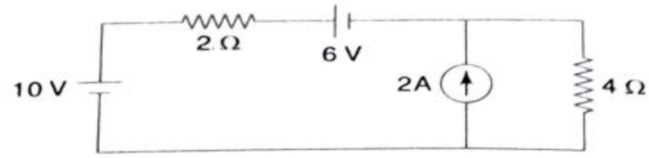

Fig. 1.95

By adding the series voltage sources, we get the circuit as shown below:

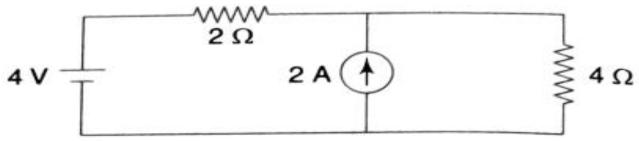

Fig. 1.96

Converting series combination of voltage source of 4 V and resistor of 2 Ω into equivalent parallel combination of current source and resistor, we get the following circuit:

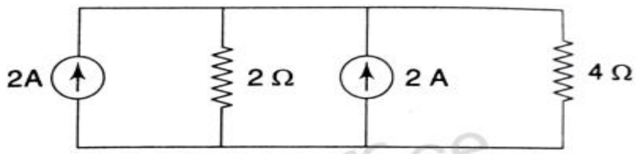

Fig. 1.97

By adding the parallel current sources, we get the following circuit:

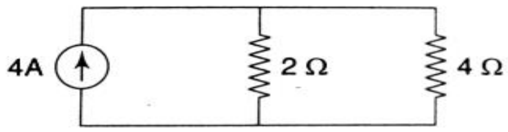

Fig. 1.98

By current division rule, we get

$$I_{4\Omega} = 4\frac{2}{2+4}$$

$$= 1.33 \text{ A } (\downarrow)$$

Example 1.29 By source transformation, find current in 3 Ω resistor in a circuit of Fig. 1.99.

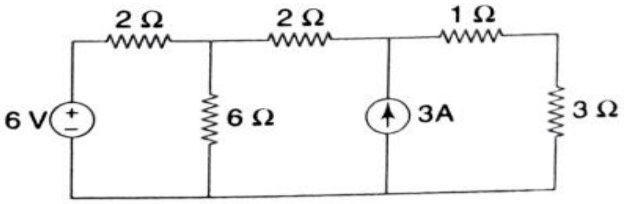

Fig. 1.99

Solution

Converting series combination of voltage source of 6 V and resistor of 2 Ω into equivalent parallel combination of current source and resistor.

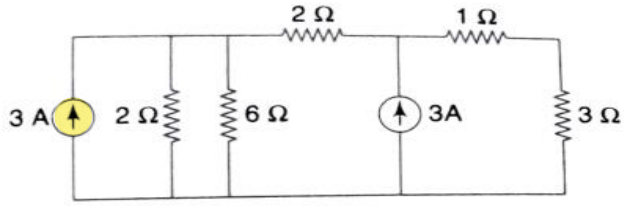

Fig. 1.100

In Fig. 1.100, resistors 6 Ω and 2 Ω are in parallel. Combining them, we get the following circuit:

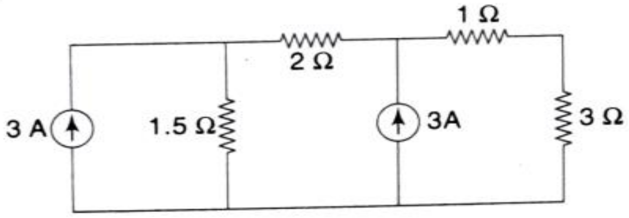

Fig. 1.101

Converting parallel combination of current source of 3 A and resistor of 1.5 Ω into equivalent series combination of voltage source and resistor, we get Fig. 1.102:

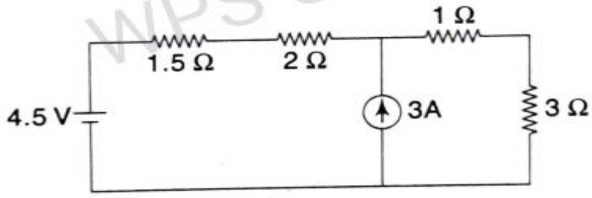

Fig. 1.102

In Fig. 1.102, resistors 1.5 Ω and 2 Ω are in series.

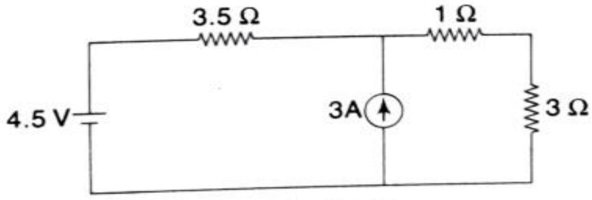

Fig. 1.103

Converting series combination of voltage source of 4.5 V and resistor of 3.5 Ω into equivalent parallel combination of current source and resistor, we get the circuit as shown in Fig. 1.104.

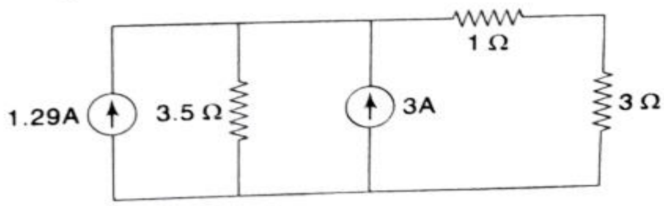

Fig. 1.104

By adding the parallel current sources, we get the circuit as shown in Fig. 1.105.
By current division rule, we obtain

$$I_{3\Omega} = 4.29 \frac{3.5}{3.5 + 1 + 3}$$

$$= 2 \text{ A } (\downarrow)$$

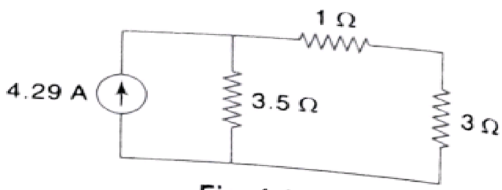

Fig. 1.105

Example 1.30 By source transformation, find current in 10 Ω resistor in the circuit shown in Fig. 1.106.

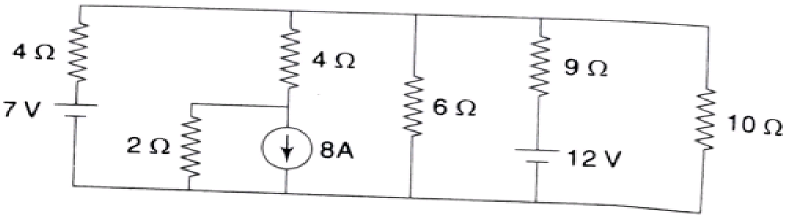

Fig. 1.106

Solution

In the circuit of Fig. 1.106, there are three combinations as follows:

(i) Series combinations of voltage source of 7 V and resistor of 4 Ω

(ii) Parallel combination of current source of 8 A and resistor of 2 Ω

(iii) Series combination of voltage source of 12 V and resistor of 9 Ω

Converting the above three combinations into equivalent combinations, we get the simplified circuit as follows:

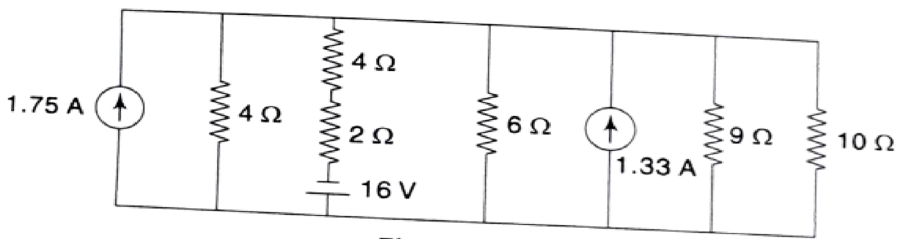

Fig. 1.107

In Fig. 1.107, resistors 4 Ω and 2 Ω are in series. Combining them, we obtain the following circuit:

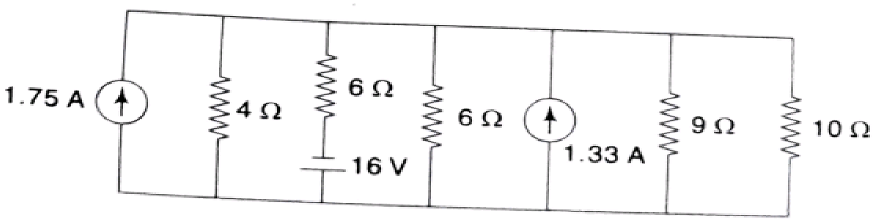

Fig. 1.108

Converting series combination of voltage source of 16 V and resistor of 6 Ω into equivalent parallel combination of current source and resistor, we get the simplified circuit as follows: