BIPOLAR JUNCTION TRANSISTOR

Basically, it consists of two back-to-back *P-N* junctions manufactured in a single piece of a semiconductor crystal. These two junctions give rise to three regions called *emitter, base* and *collector*. As shown in Fig., a junction transistor is simply a sandwich of one type of semiconductor material between two layers of the other type. Fig. (*a*) shows a layer of *N*-type material sandwiched between two layers of *P*-type material. It is described as a *PNP* transistor, Fig. (*b*) shown an *NPN* transistor consisting of a layer of *P*-type material sandwiched between two layers of *N*-type material.

The emitter, base and collector are provided with terminals which are labelled as *E. B* and *C*. The two junctions are: emitter-base (*E/B*) juction and collector-base (*C/B*) junctions.

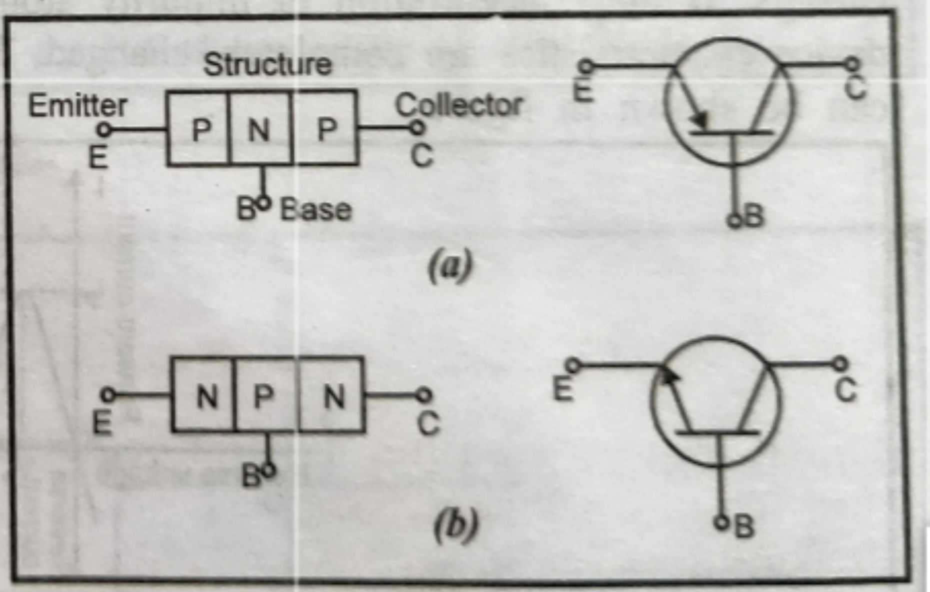
The symbols employed for *PNP* and *NPN* transistors are also shown in Figure. The arrowhead is always at the emitter (not at the collector) and in each case, its direction indicates the *conventional* direction of current flow. For a *PNP* transistor, arrowhead points from emitter to base meaning that emitter is positive with respect to base (and also, with respect to collector). For *NPN* transistor, it points from base to emitter meaning that base (and collector as well) is positive with respect to the emitter.

1. Emitter

It is more heavily doped than any of the other regions because, its main function is to supply majority charge carriers (either electrons or holes) to the base.

2. Base

It forms the middle section of the transistor. It is very thin (10^{-6} m) as compared to either the emitter or collector and is very *lightly-doped*.



3. Collector

Its main function (as indicated by its name) is to collect majority charge carriers coming from the emitter and passing through the base.

In most transistors, collector region is made physically larger than the emitter region because it has to dissipate much greater power. Because of this difference, there is no possibility of inverting the transistor, *i.e.* making its collector the emitter and its emitter the collector.

Transistor Biasing

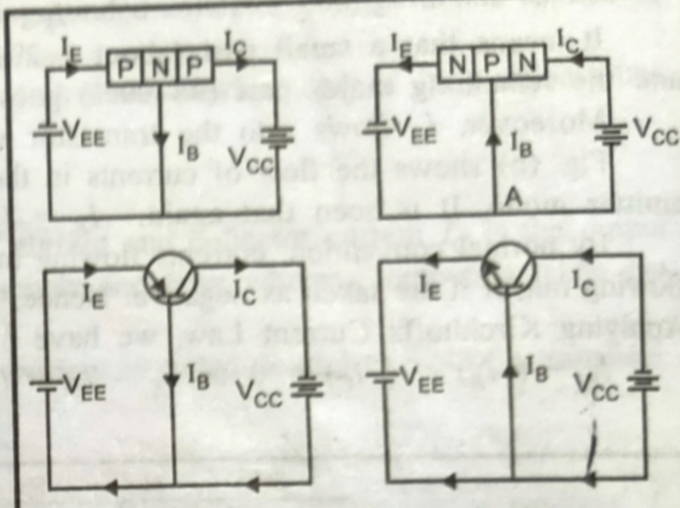
For proper working of a transistor, it is essential to apply voltages of correct plarity across its two junctions. It is worthwhile to remember that for normal operation;

1. emitter-base junction is always forward-biased and
2. collector-base junction is always reverse-biased.

This type of biasing is known as *FR* biasing.

In figure, two batteries respectively, provide the dc emitter supply voltage V_{EE} *and* collector supply voltage V_{CC} for properly biasing the two junctions of the transistor. In Fig. (*a*). Positive terminal of V_{EE} is connected to P-type emitter in order to *repel* or push holes into the base.

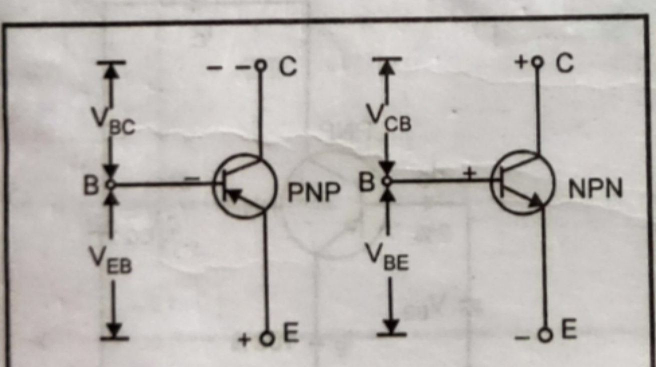
The negative terminal of V_{CC} is connected to the collector so that it may *attract* or *pull* holes through the base. Similar considerations apply to the *NPN* transistor of Fig. (*b*). It must be remembered that a transistor will never conduct any current, if its emitter-base junction is not forward-biased.



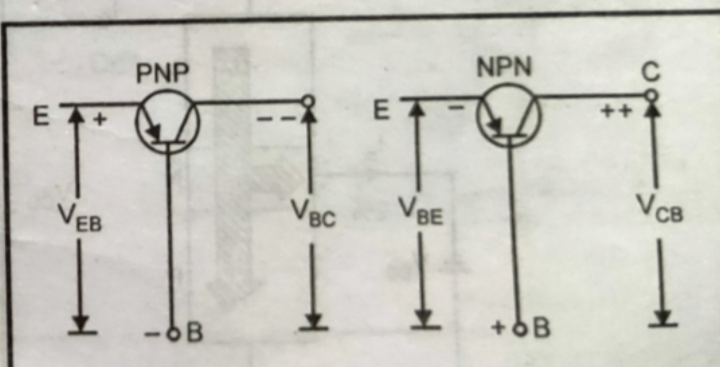
(a) (b)

Important Biasing Rule

For a *PNP* transistor, both collector and base are negative with respect to the emitter (the lett *N* of Negative being the same as the middle letter of *PNP*). Of course, collector is more negati than base [Fig. (A)]. Similarly, for NPN transistor, both collector and base are positive with respe to the emitter (the letter *P* of Positive being the same as the middle letter of *NPN*). Again, collect is *more positive* than the base as shown in Fig. (B).



(A) (B)



(C) (D)

It may be noted that different potentials have been designated by double subscripts. T first subscript always represents the point or terminal which is more positive (or less negati than the point or terminal represented by the second subscript. For example, in Fig. (A), potential difference between emitter and base is written as V_{EB} (and not V_{EE}) because, emi is positive with respect to base. Now, between the base and collector themselves, collector is more negative than base. Hence, their potential difference is written as V_{BC} and not as V_{CB}. Same is the case with voltages marked in Fig. C & D.

Transistor Currents

The three primary currents which flow in a properly-biased transistor are I_E, I_B and I_C. In Fig. (a) are shown the directions of flow as well as relative magnitudes of these currents for a *PNP* transistor connected in the common-base mode. It is seen that

$$I_E = I_B + I_C$$

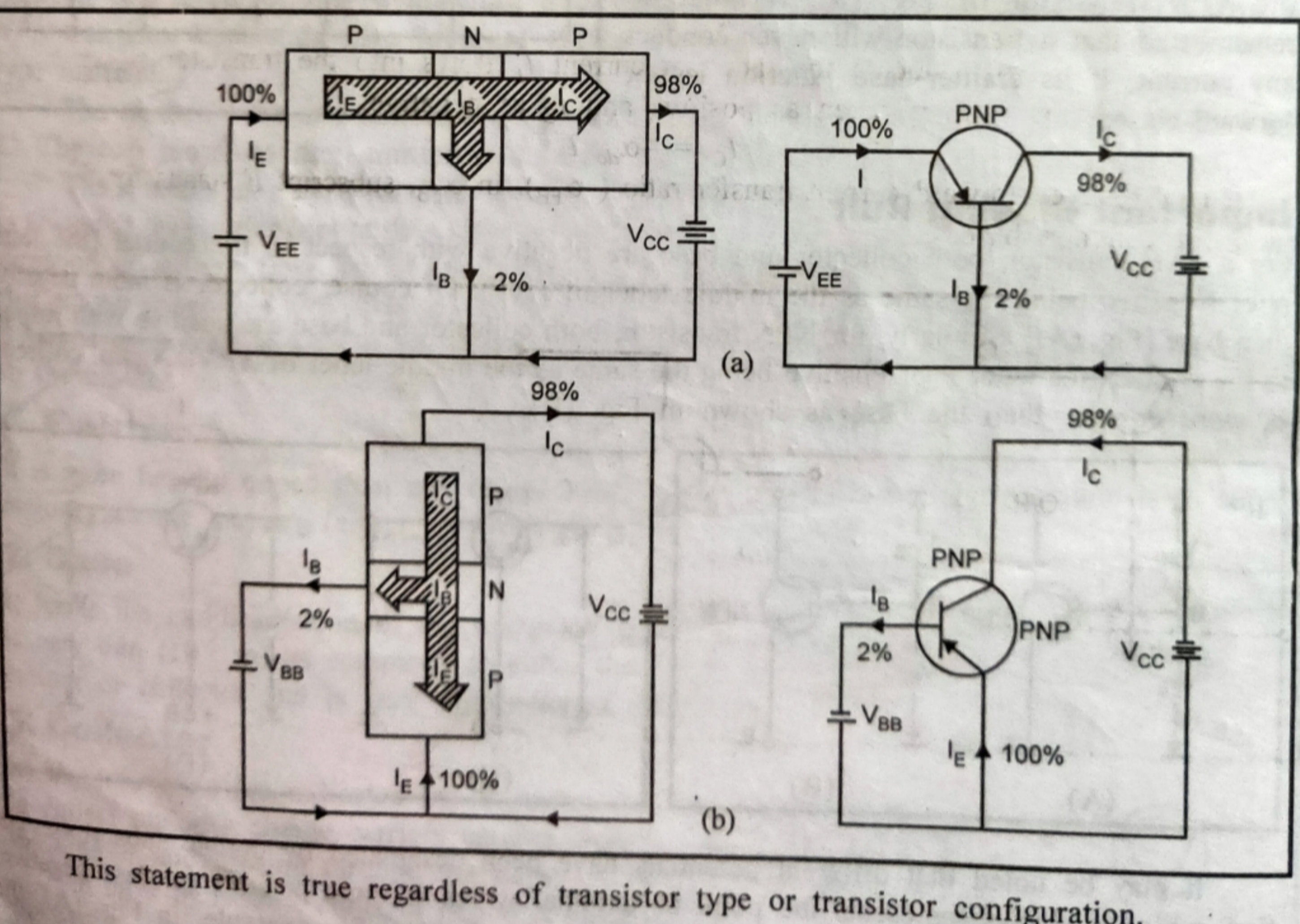
It means that a small part (about 1–2%) of emitter current goes to supply base current and the remaining major part (98–99%) goes to supply collector current.

Moreover, I_E flows into the transistor whereas, both I_B and I_C flow out of it.

Fig. (b) shows the flow of currents in the same transistor when connected in the common-emitter mode. It is seen that again. $I_E = I_B + I_C$

By normal convention, currents flowing into a transistor are taken as positive whereas, those flowing out of it are taken as negative. Hence, I_E is positive whereas, both I_B and I_C are negative. Applying Kirchhoffs Current Law, we have

$$I_E + (-I_B) + (-I_C) = 0 \text{ or } I_E - I_B - I_C = 0 \text{ or } I_E = I_B + I_C$$



This statement is true regardless of transistor type or transistor configuration.