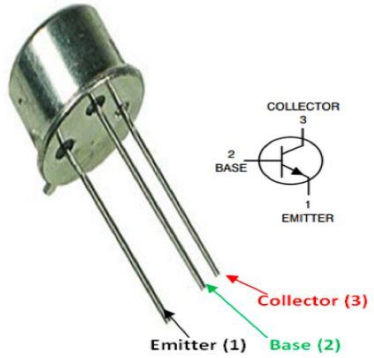
JUNCTION TRANSISTOR STRUCTURE
&
SURPRISING ACTION OF TRANSISTOR



BIPOLAR JUNCTION TRANSISTORS (BJTs)

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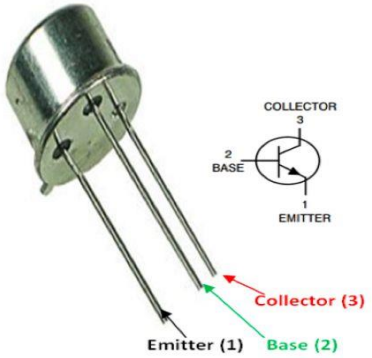
INTRODUCTION



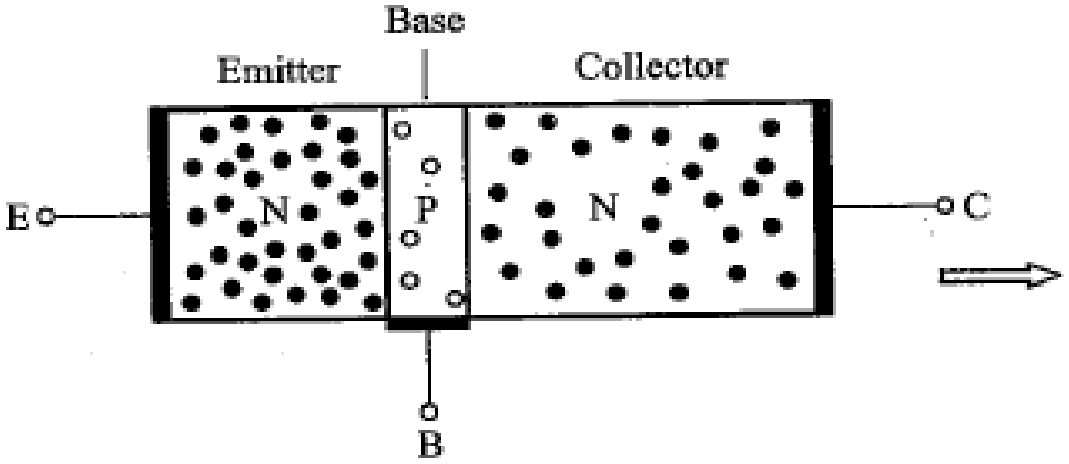
Invented in 1948

By
John Bardeen, Walter Brattain and William Shockley
@ Bell Laboratories in America

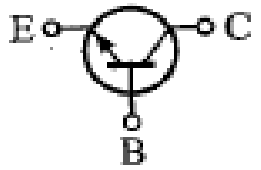
Revolutionized the electronics industry

JUNCTION TRANSISTOR STRUCTURE

Majority Charge Carriers: Electrons
Minority Charge Carriers: Holes

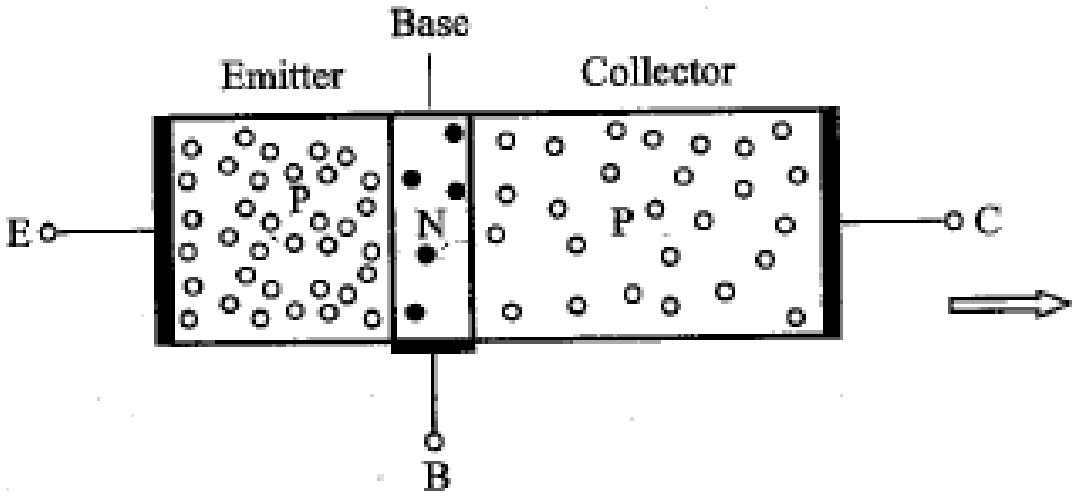


(*a*) NPN-type

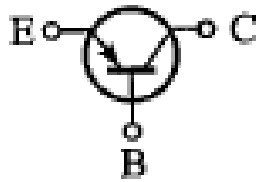


(*b*) NPN-transistor symbol

Majority Charge Carriers: Holes
Minority Charge Carriers: Electrons



(*c*) PNP-type



(*d*) PNP-transistor symbol

Transistor is basically a silicon or germanium crystal

THREE separate regions

NPN-type or PNP-type

Emitter : Heavily doped :emit or inject electrons (holes in case of PNP transistor) in to the base

Base : Lightly doped : passes most of these electrons(holes in PNP) from emitter on to collector

Collector : Moderately doped : collects electrons(holes in PNP) from base

A transistor has two PN-junctions

The junction between the emitter and the base and is called the
emitter-base junction or simply the *emitter junction*

The junction between the collector and the base and is called the
collector-base junction or simply the *collector junction*

THE SURPRISING ACTION OF A TRANSISTOR

2 junctions

emitter junction and
a collector junction

4 ways of biasing

Condition		Emitter Junction	Collector Junction	Region of operation
I	FR	Forward biased	Reverse biased	Active
II	FF	Forward biased	Forward biased	Saturation
III	RR	Reverse biased	Reverse biased	Cutoff
IV	RF	Reverse biased	Forward biased	Inverted

FR CONFIGURATION

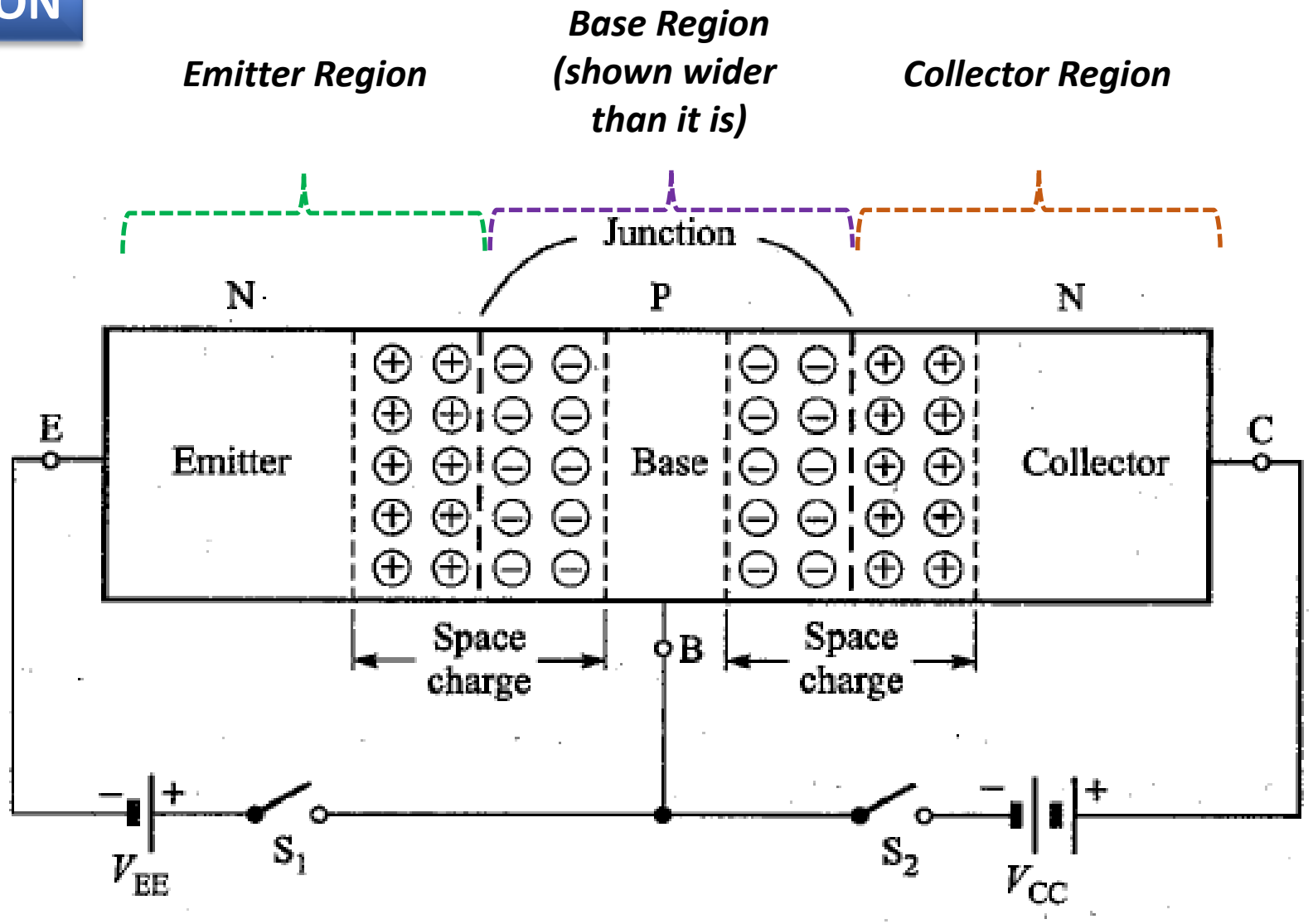


Fig : Biasing an NPN transistor for active operation

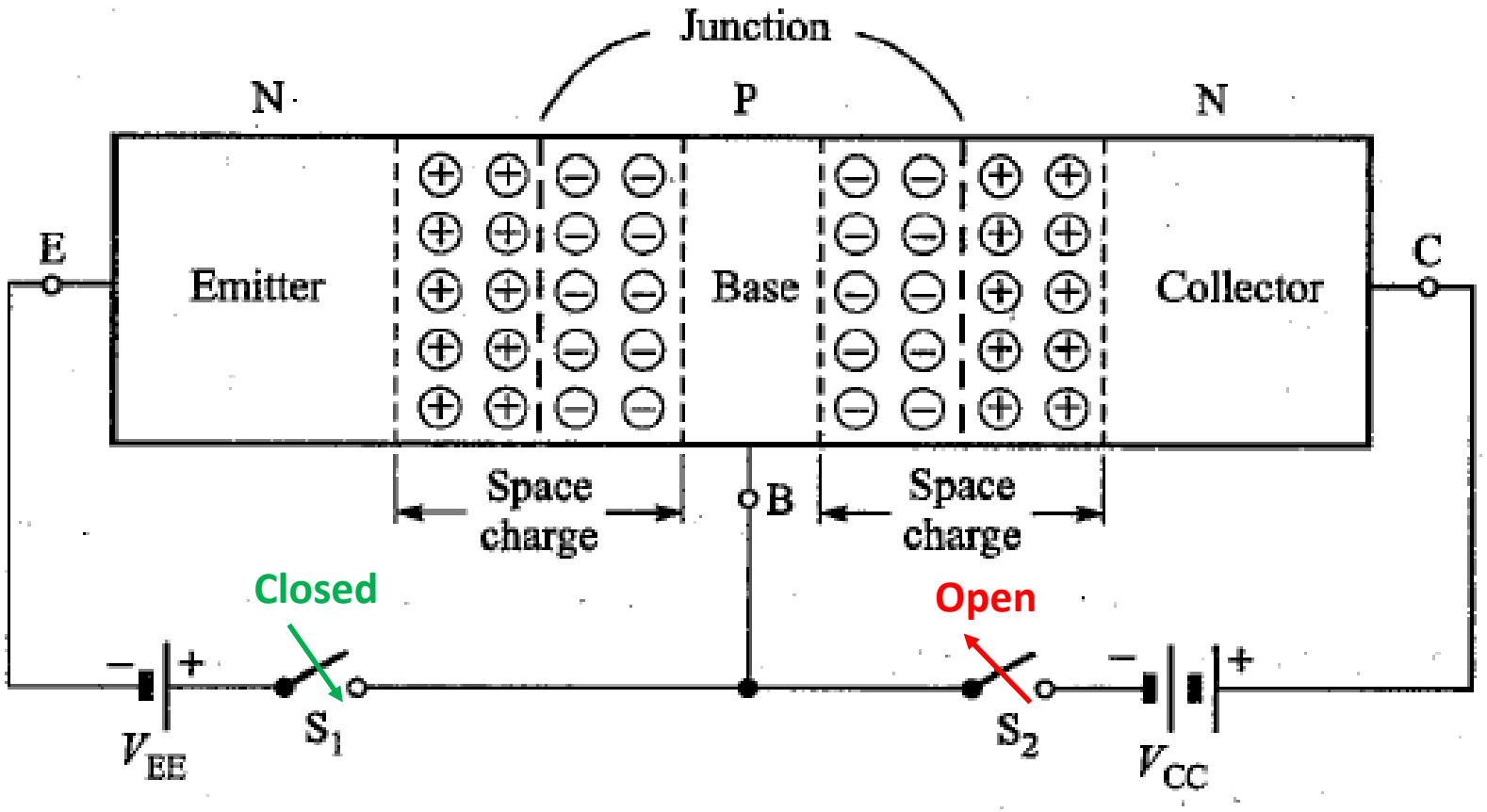
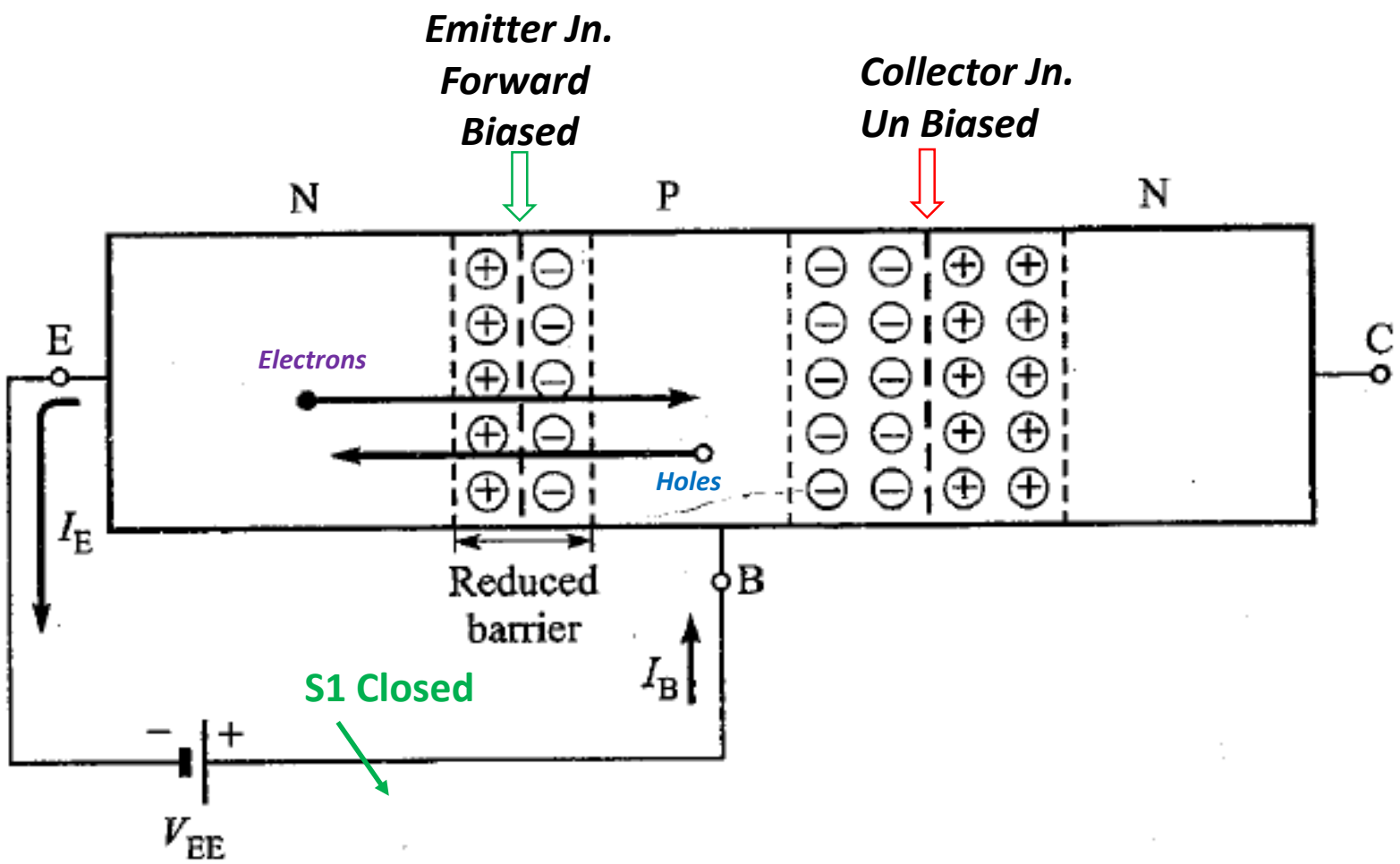


Fig : Biasing an NPN transistor for active operation



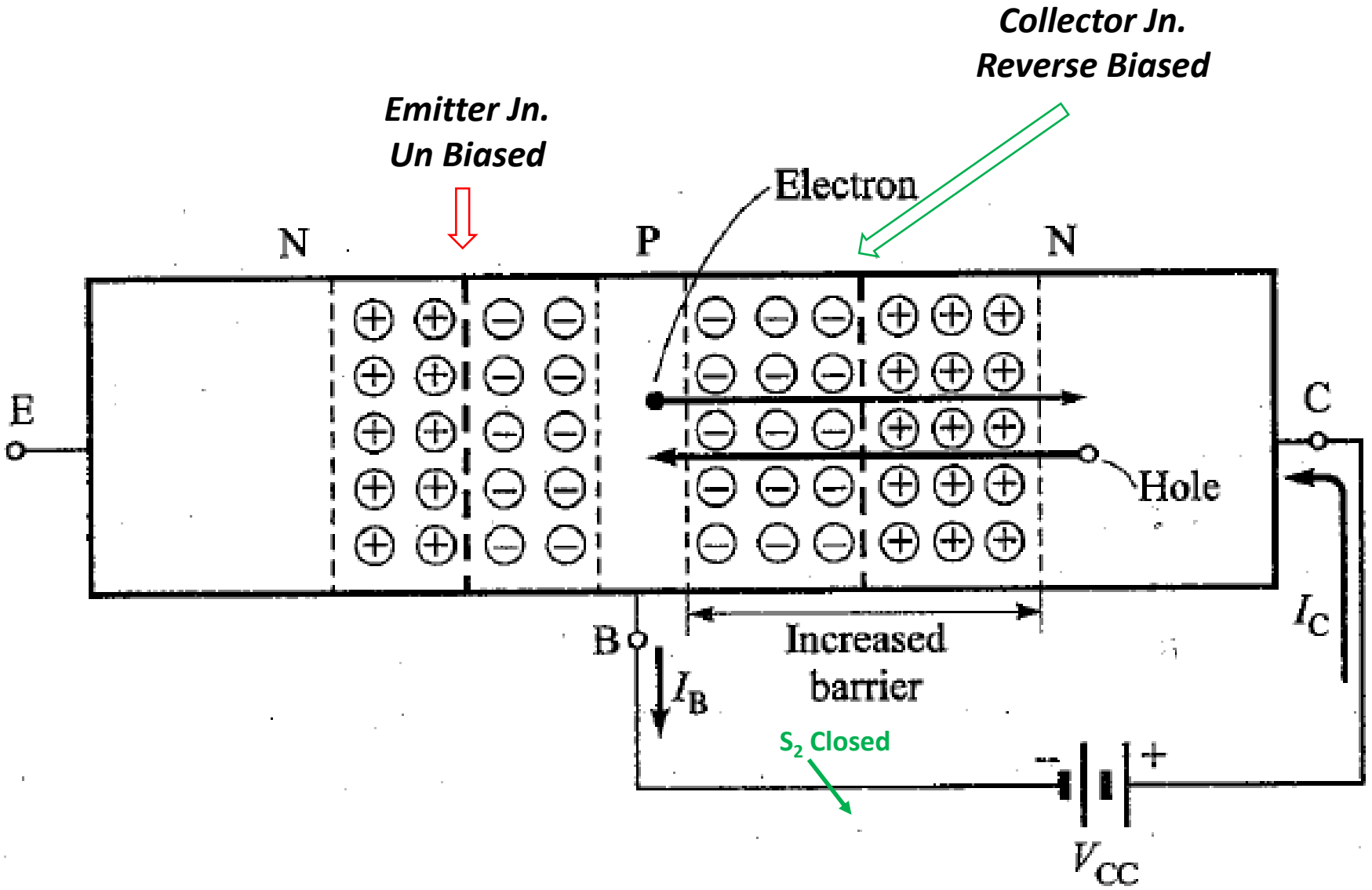
Total current flowing across the junction is sum of electron diffusion current and hole diffusion current

Base → Deliberately Doped → Few Holes → VERY LESS HOLE CURRENT

Emitter → Heavily Doped → Majority electron carriers → 99% ELECTRON CURRENT diffusing from emitter to base

Emitter currents (I_E) and Base currents (I_B) are quite large and equal ($I_E = I_B$)

Collector current (I_c) = 0

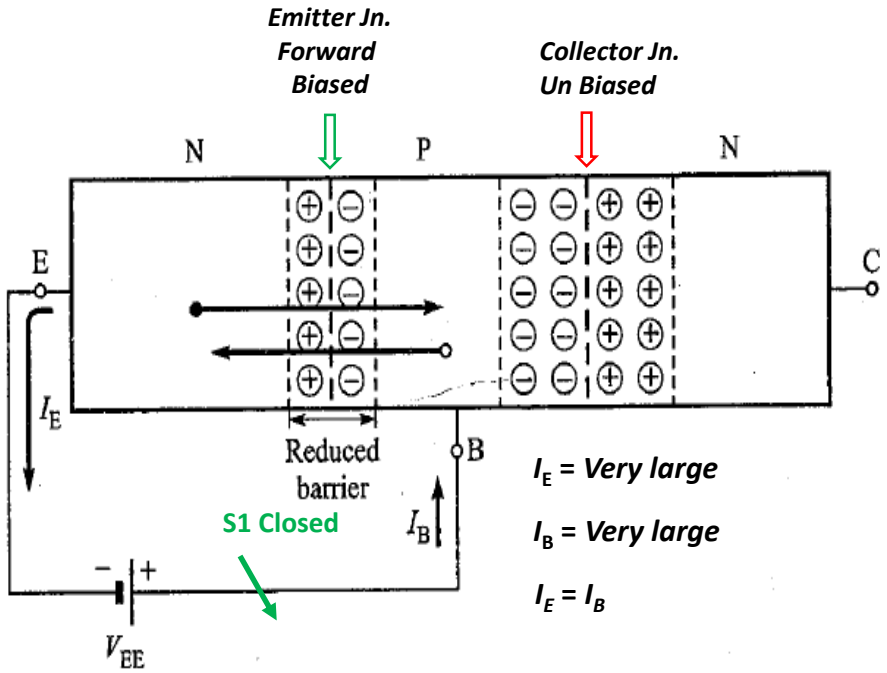


Very small current flows across this reverse-biased junction

The reverse leakage current (I_{CBO}) is due to the movement of minority carriers.

The current flows into the collector lead and out of the base lead.

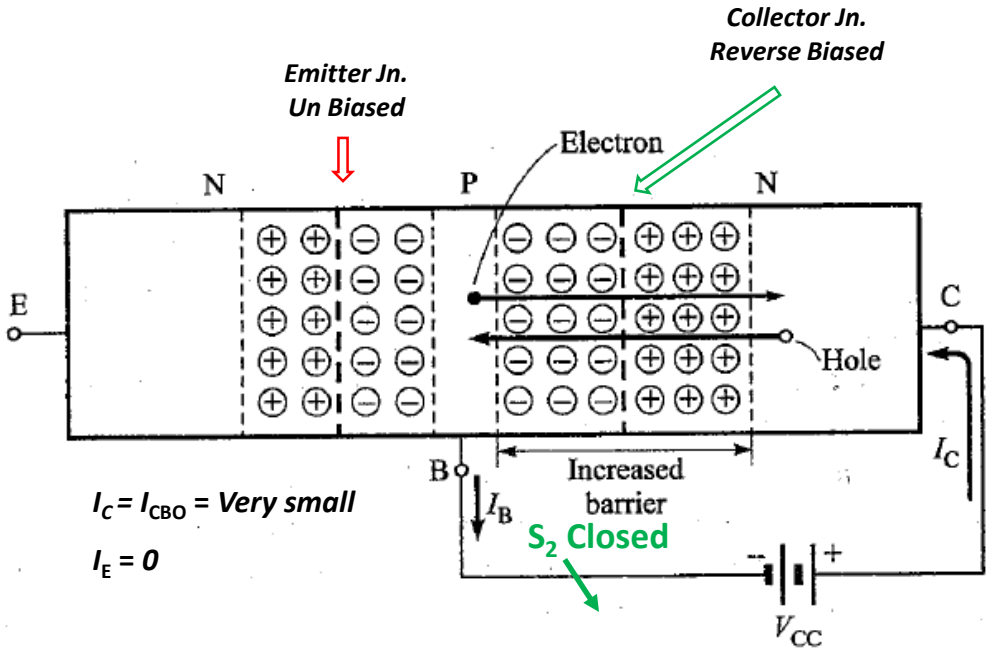
There is no emitter current ($I_E = 0$).



I_E = Very large

I_B = Very large

$I_E = I_B$



$I_C = I_{CBO}$ = Very small

$I_E = 0$

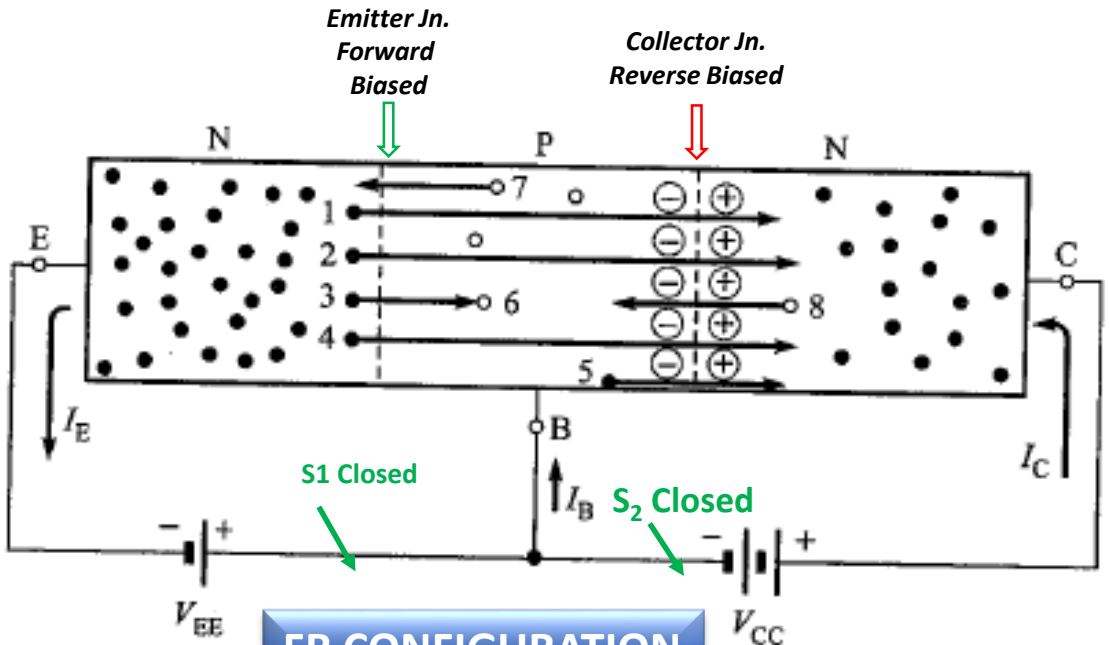
Expected

I_E = Very large

I_B = Very large

$I_E = I_B$

$I_C = I_{CBO}$ = Very small



FR CONFIGURATION

Actual

I_E =large (as expected)

I_B = very small(surprising)

I_C = large current(surprising)

In the next section,
we shall investigate the reason for I_C being large and I_B being small.