

# Electronics - Fancy Circuit Devices

***Edison effect.*** Edison patented the idea, but couldn't think of anything useful to do with it.

***thermonic emmision.***

1904 John Ambrose Fleming

Fleming called it a valve

***diode*** or ***rectifier*** -- only let electricity flow in one direction

negative -- ***cathode.***

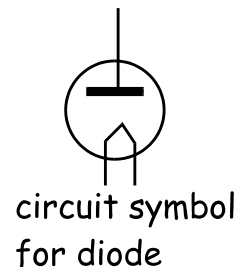
other electrode -- ***plate*** or ***anode***

1906 Lee De Forest -- extra element

***grid*** -- ***triode***

***Transistor*** 1948.

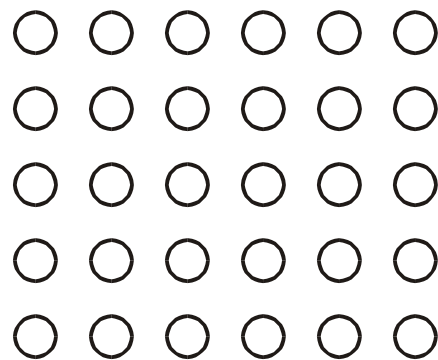
William Shockley , Walter Brattain, and John Bardeen



Pure silicon -- lousy conductor

crystal is made up of a lattice of silicon atoms bonded together with covalent bonds

structure is similar to a diamond.



***Doping -- add phosphorous atom***

Get extra electron

Silicon doped with phosphorous has free electrons and can conduct electricity

"N type" - has negative charge carriers

dope with aluminum

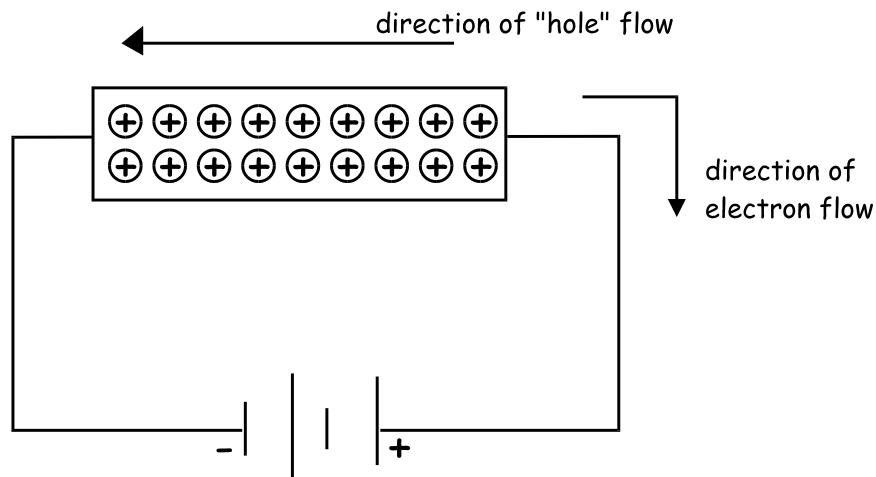
Aluminum has a valence of three

Get a hole

holes act as *positive charge carriers*

P type semiconductors.

Conduction in the P type crystal via hole flow.



is

Current flow through P type crystal

solid state diode -- *junction*

At junction -- holes & electrons combine

Form *depletion zone*

Add voltage, -- BIAS

No current with reverse bias

Electricity will flow when the anode is more positive than the cathode.

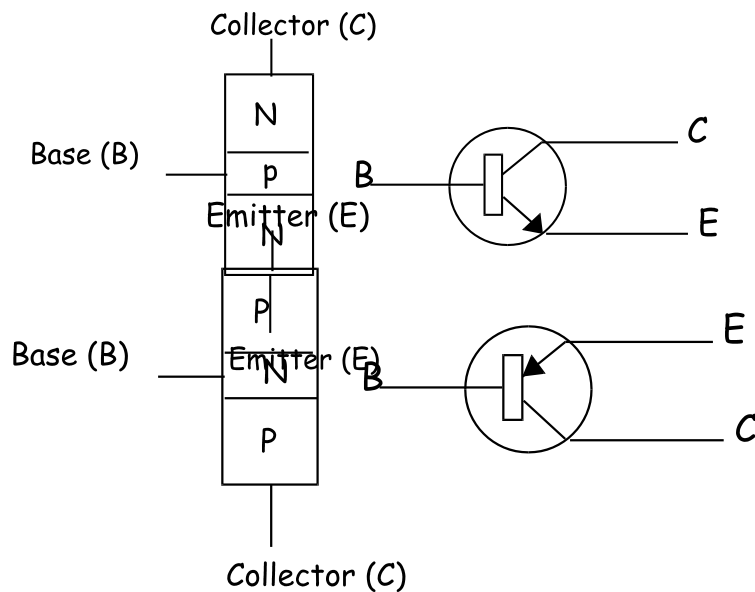
## ***Transistors:***

PNP transistors.

NPN transistor.

two P-N junctions. They are made from three thin layers of differing crystal.

small signal applied to the base controls larger current traveling through the emitter/collector path.



The base is very thin and it acts like a gate

When it is forward biased, current can flow

When it is reverse biased, current cannot flow

The signal that is applied to the base controls its charge and therefor controls its ability to allow current to flow.

symbol for transistors

arrow shows direction of hole flow

arrow points to N material

negative terminal of battery is connected to the N type emitter

positive terminal is connected to the P type base

emitter-base circuit is *forward biased*

In the collector-base circuit

N type collector -- positive battery terminal

P type base is connected to negative battery terminal

collector-bias circuit is *reverse biased*.

Electrons enter from the negative battery terminal and flow to junction

electrons flow into base -- fill holes

base is very thin, like 0.0005 cm, so electrons end up in the collector

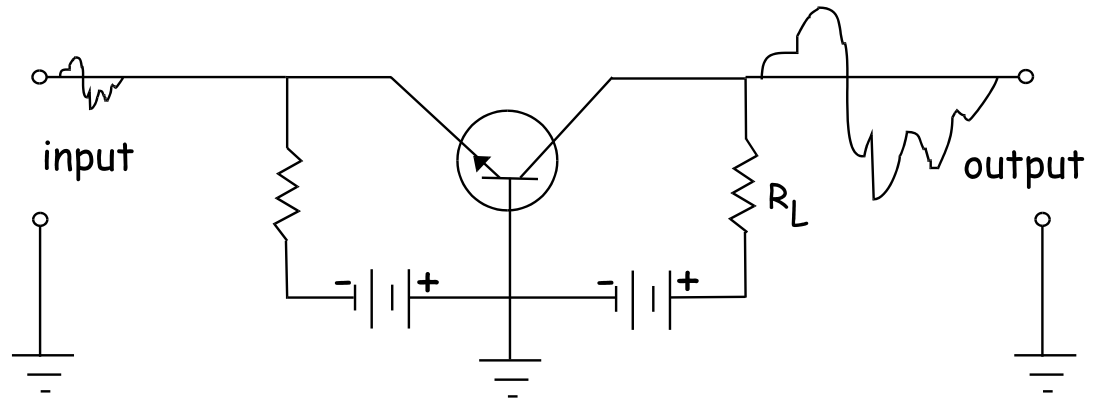
95 to 98 % of the current is through the emitter/collector

2 to 5 % is through the emitter-base

small change in emitter bias voltage will cause a relatively large change in emitter-collector current.

typical  
amplifier

NPN  
transistor



Common or grounded base amplifier