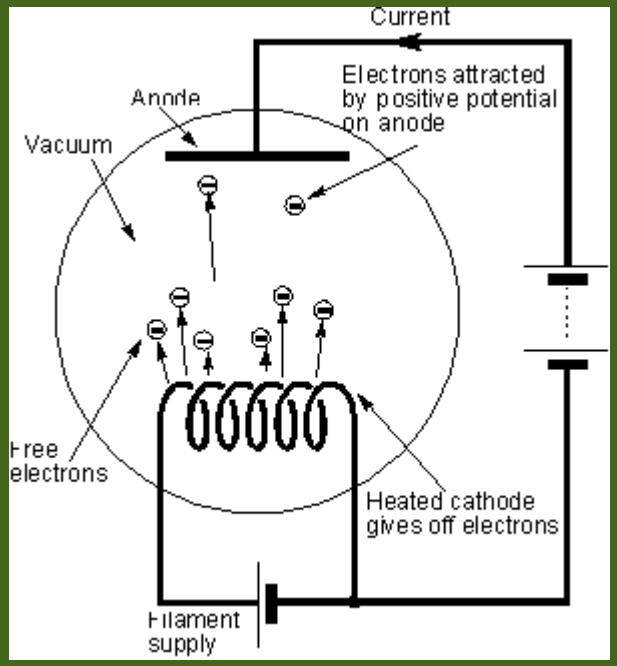
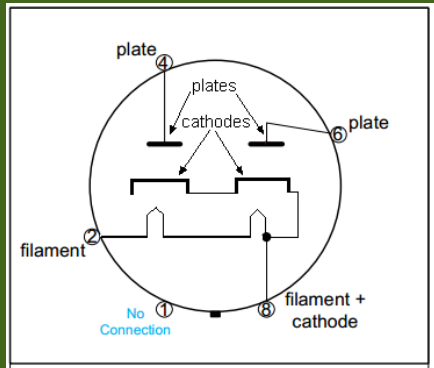
Válvulas,
Semicondutores e
Fontes de alimentaçao.

Diodos, junçoes PN

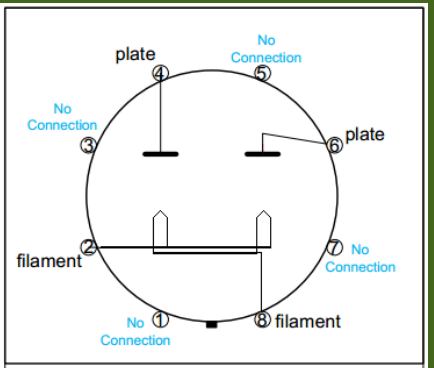
Vacuum tubes (válvulas)

Vacuum Tubes (Valvulas)
Diodo

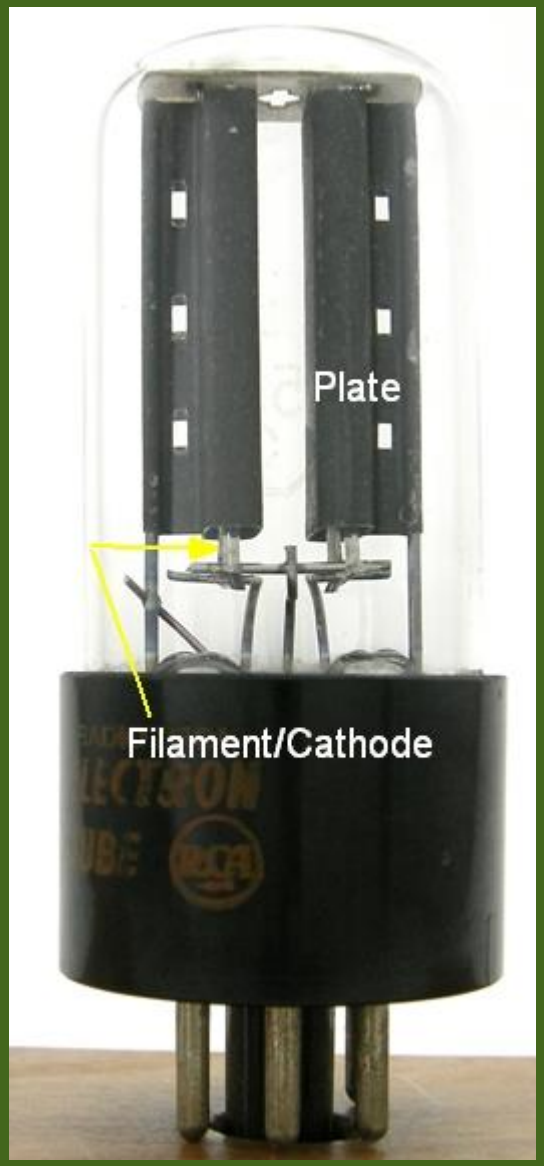




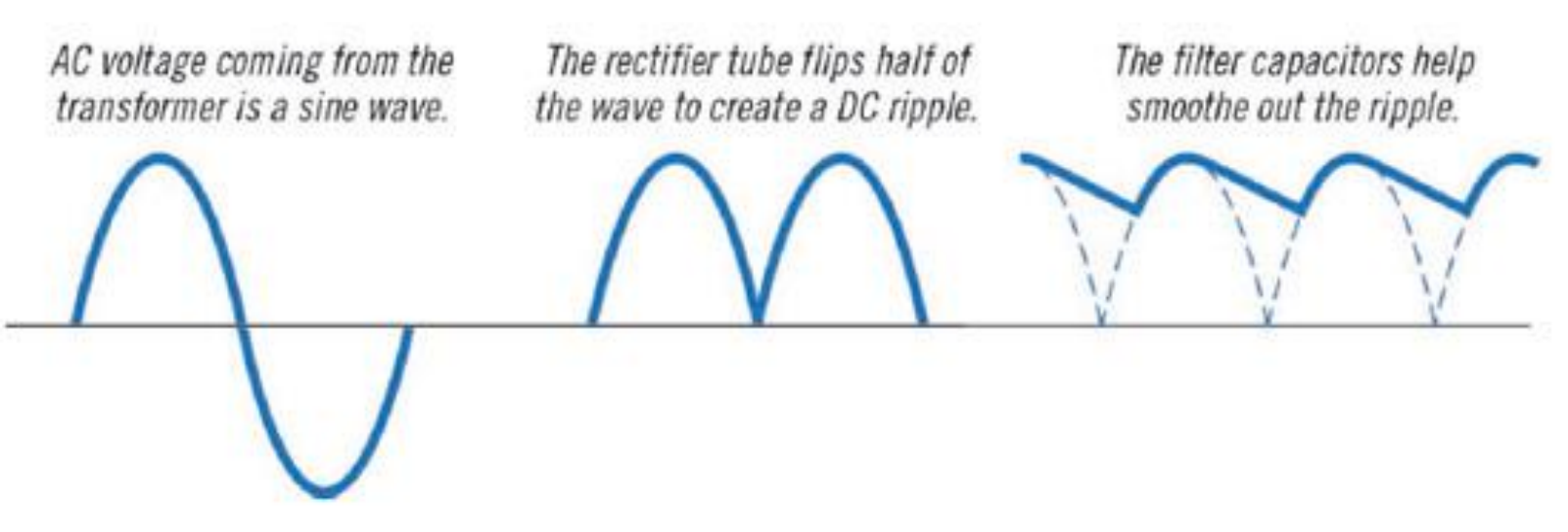
5AR4/GZ34



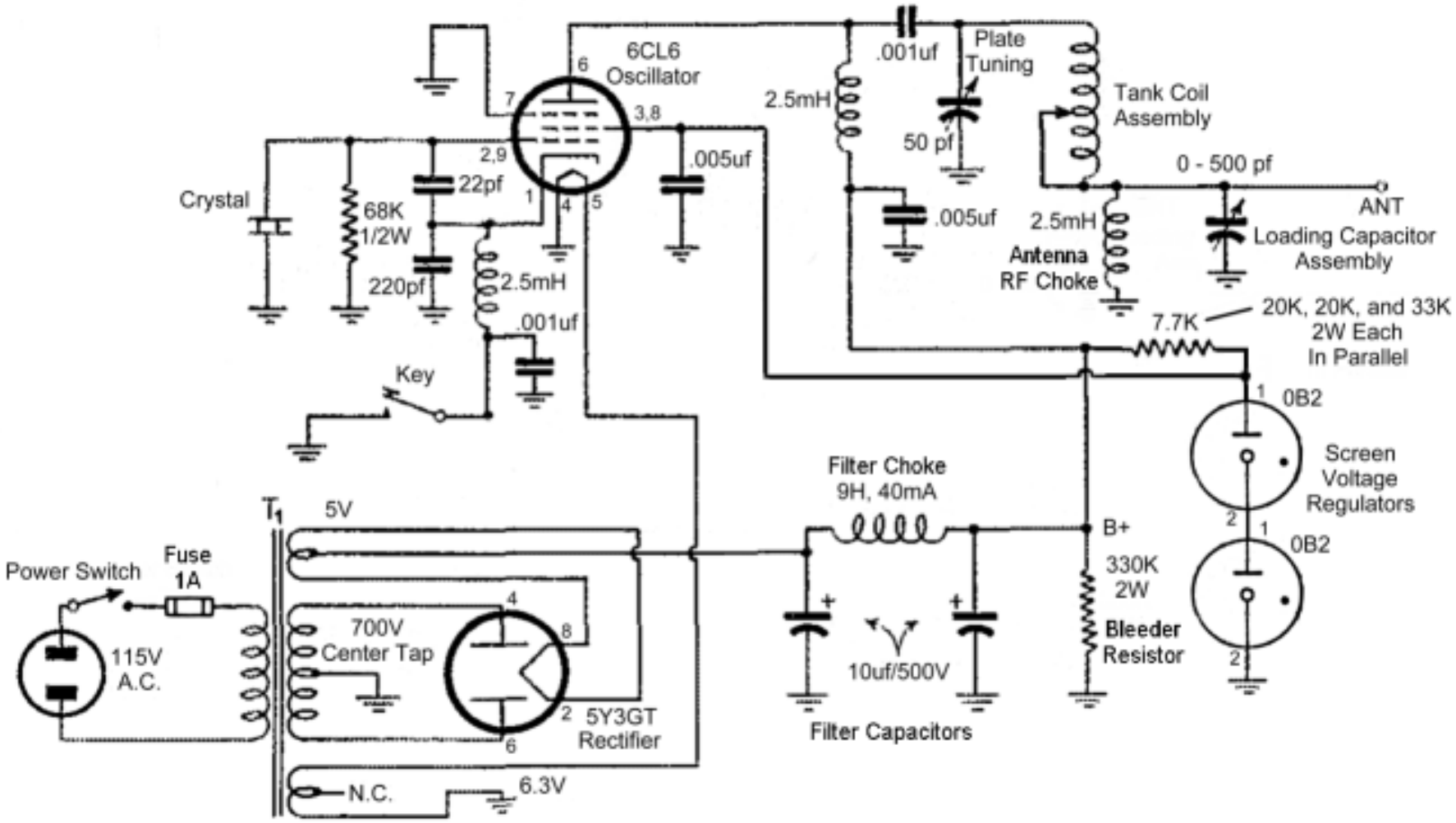
5U4GB, 5Y3GT



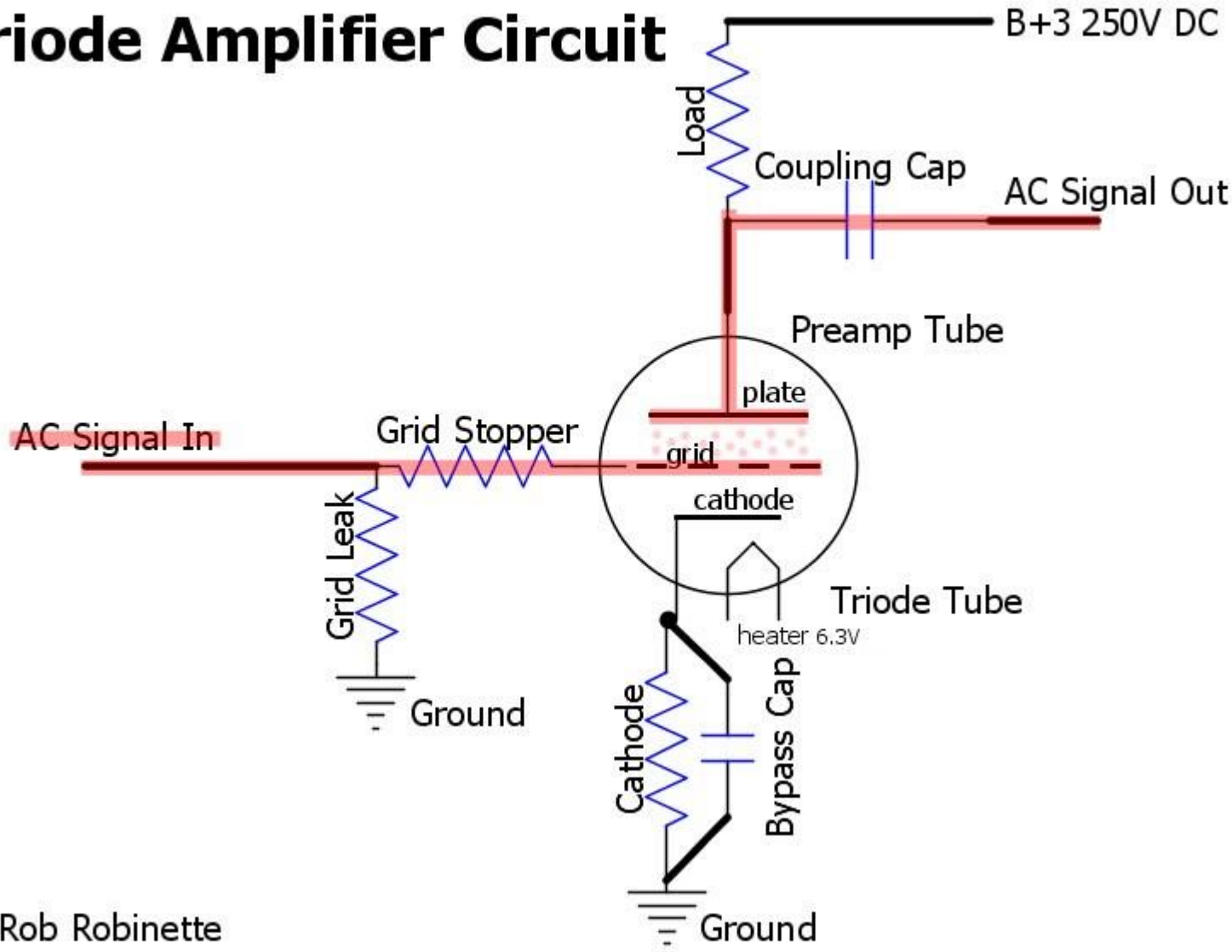
5Y3GT Rectifier


AC voltage coming from the transformer is a sine wave.
The rectifier tube flips half of the wave to create a DC ripple.
The filter capacitors help smoothe out the ripple.

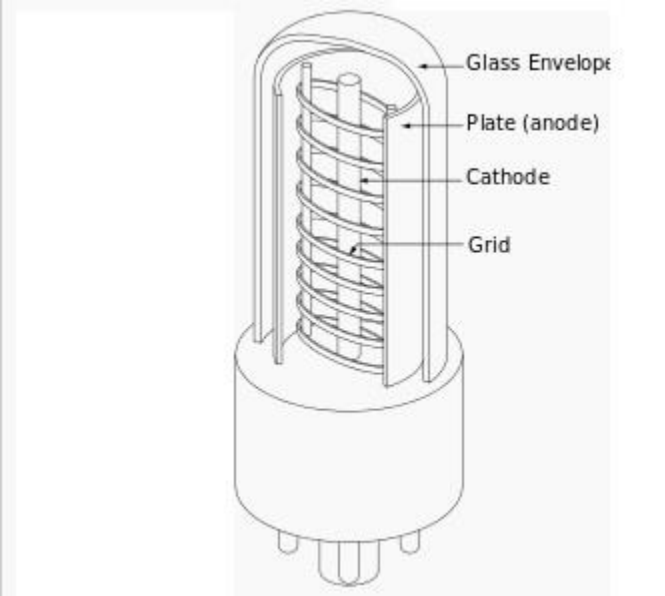
AA8V/W8EXI 6CL6 One-Tube Transmitter

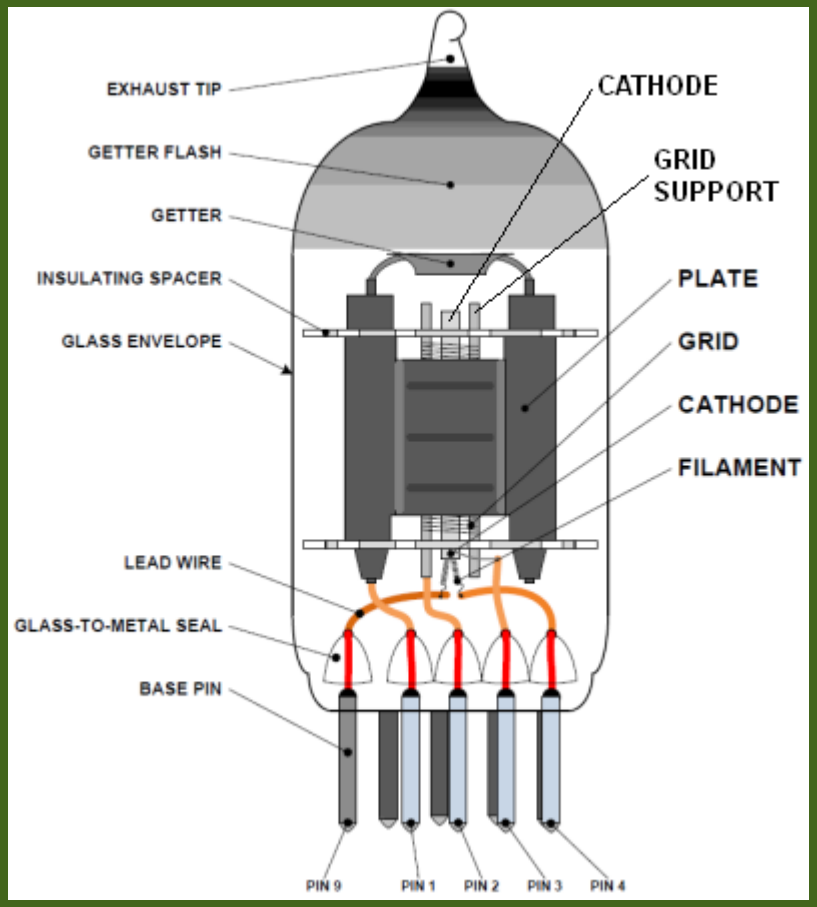


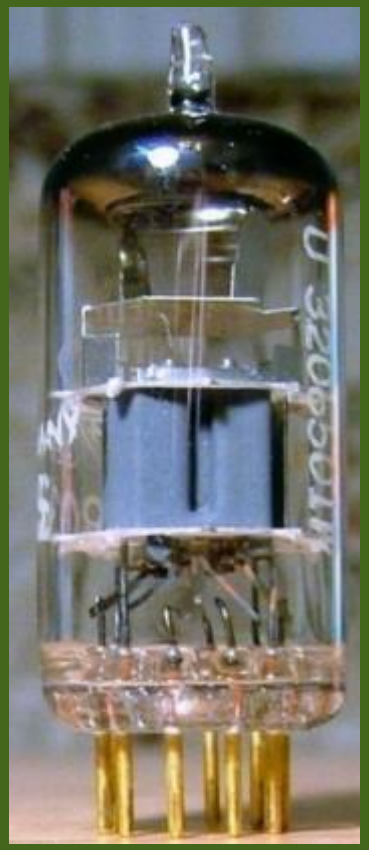
Triode Amplifier Circuit



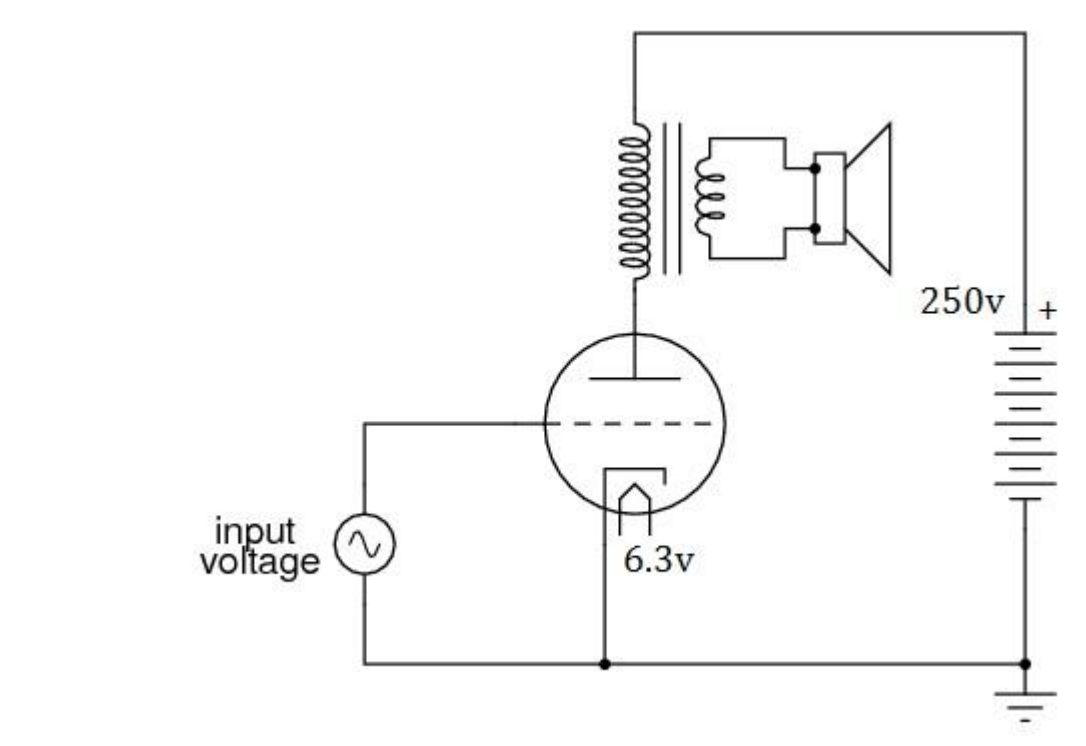
By Rob Robinette


Glass Envelope
Plate (anode)
Cathode
Grid


EXHAUST TIP
GETTER FLASH
GETTER
INSULATING SPACER
GLASS ENVELOPE
LEAD WIRE
GLASS-TO-METAL SEAL
BASE PIN
CATHODE
GRID SUPPORT
PLATE
GRID
CATHODE
FILAMENT
PIN 9
PIN 1
PIN 2
PIN 3
PIN 4



Triode amplifier
Output transformer



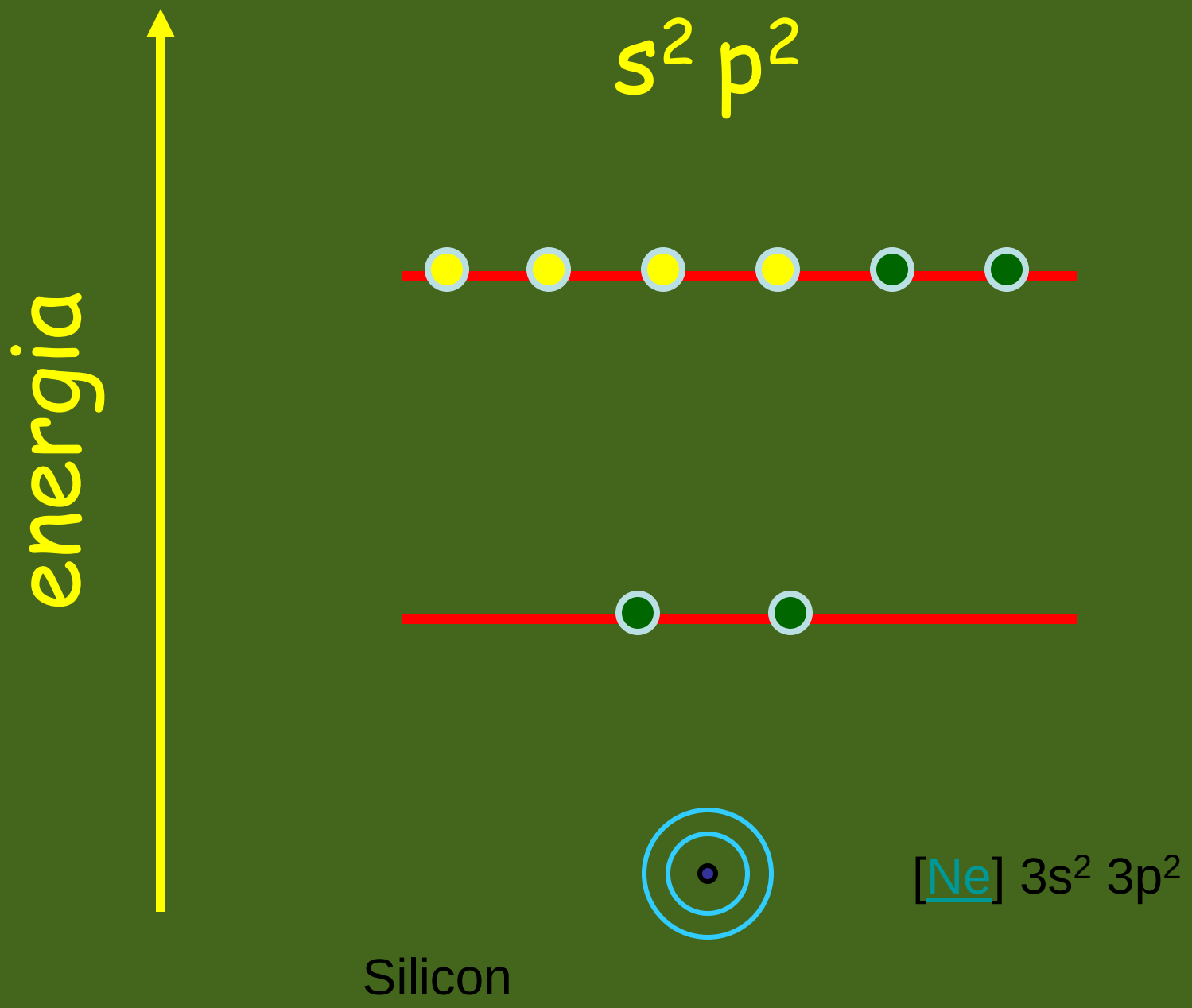
In general, vacuum tubes are much less susceptible than corresponding solid-state components to transient overvoltages, such as mains voltage surges or lightning, the electromagnetic pulse effect of nuclear explosions.

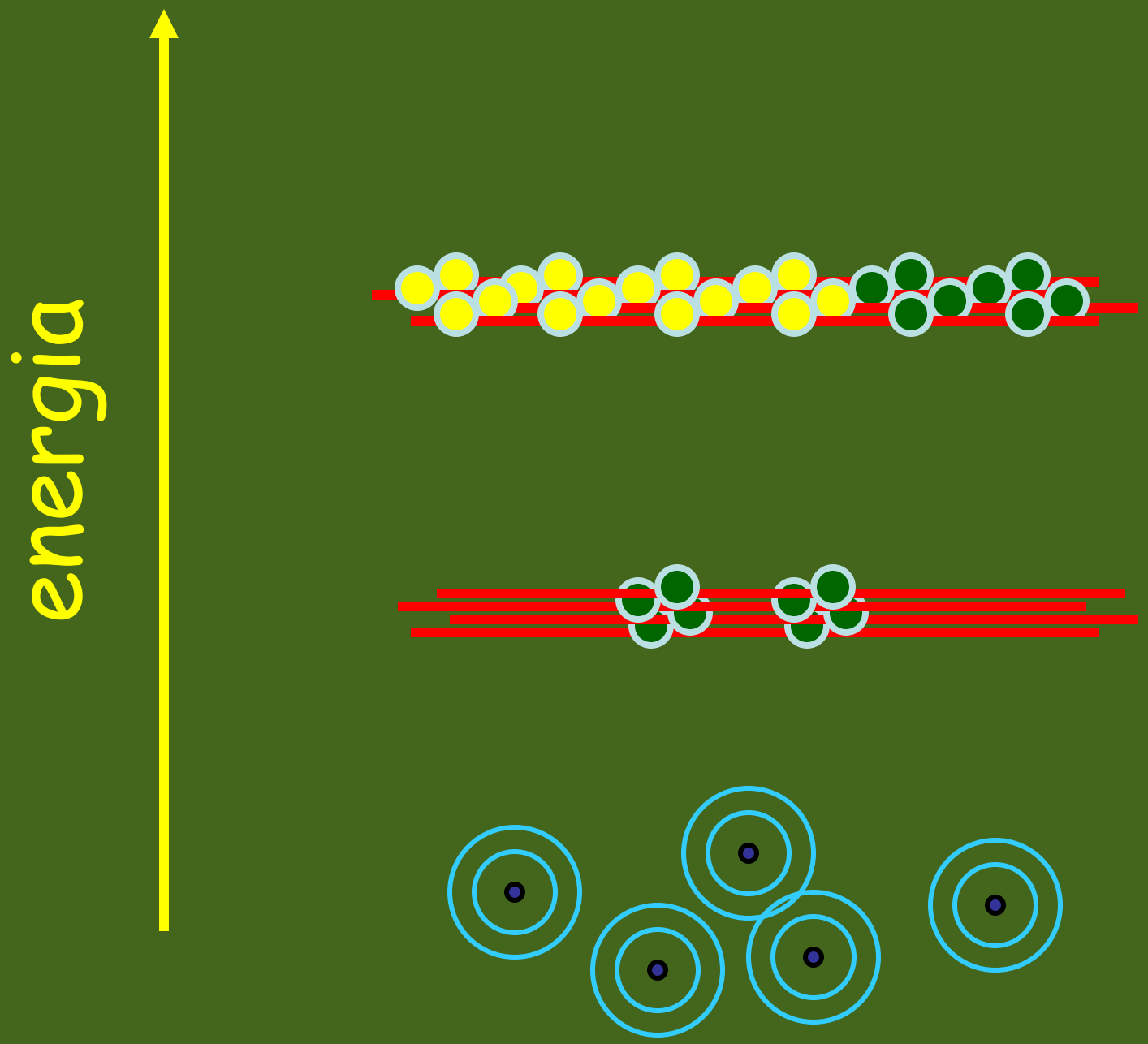
Vacuum tubes are still practical alternatives to solid-state devices in generating high power at radio frequencies (Klystron)

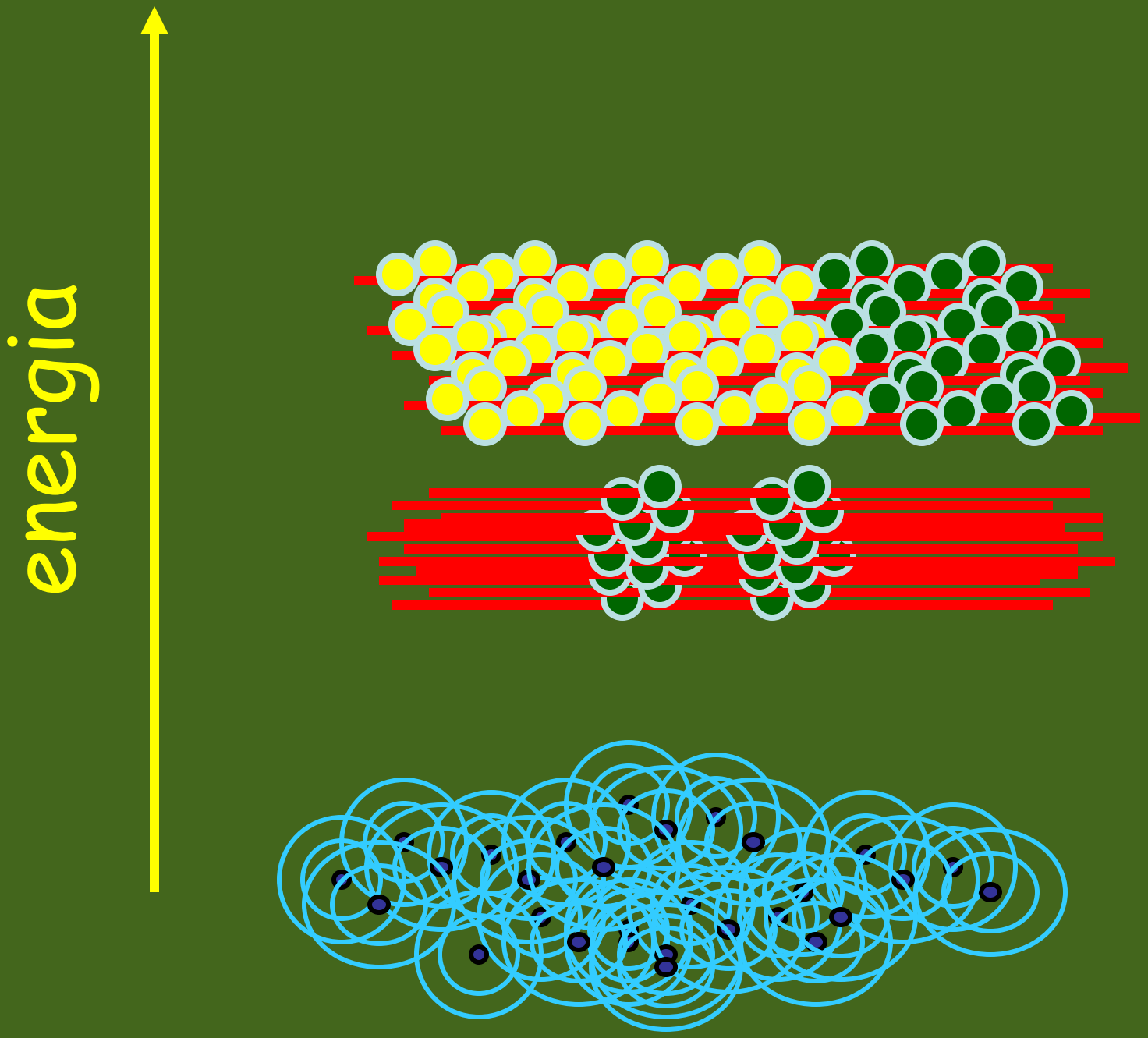
In military applications, a high-power vacuum tube can generate a 10–100 megawatt signal that can burn out an unprotected receiver's frontend. (Film: Matrix)

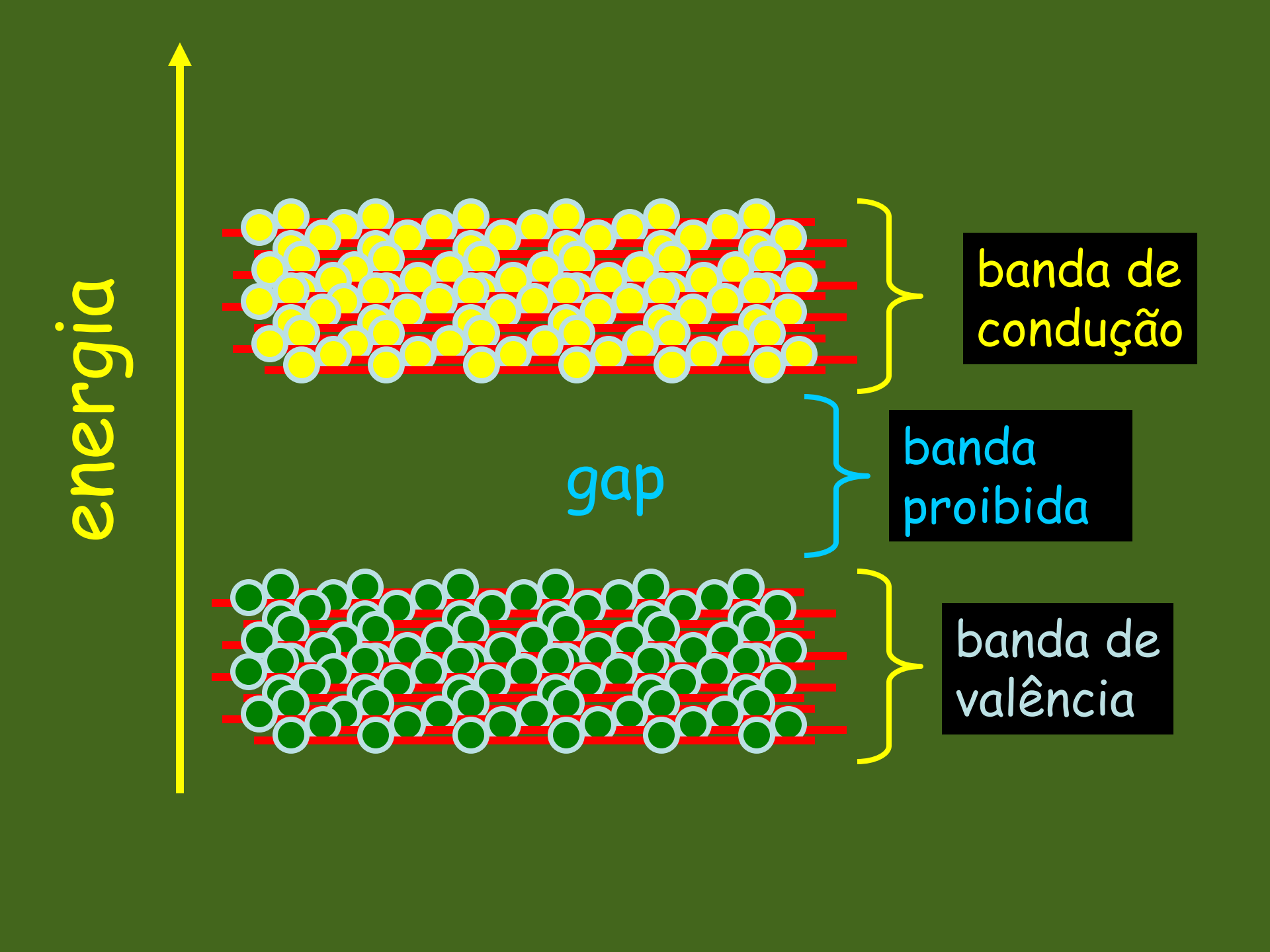
https://en.wikipedia.org/wiki/Vacuum_tube#Vacuum_tubes_in_the_21st_century

Semiconductors


$s^2\ p^2$
energia
[Ne] $3s^2\ 3p^2$
Silicon


energia


energia

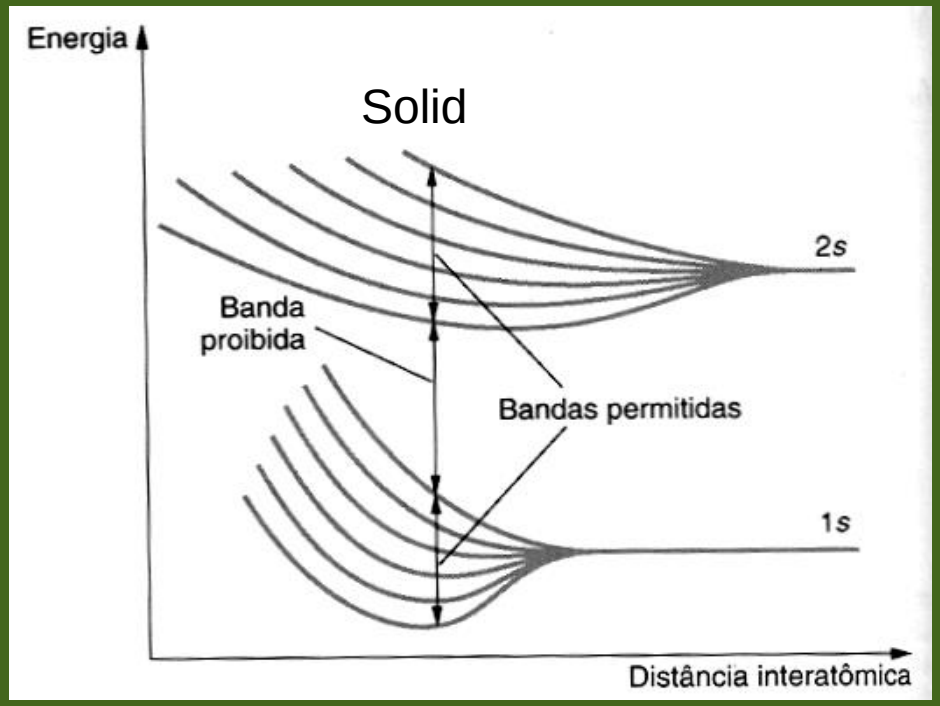

energia
banda de condução
gap
banda proibida
banda de valência

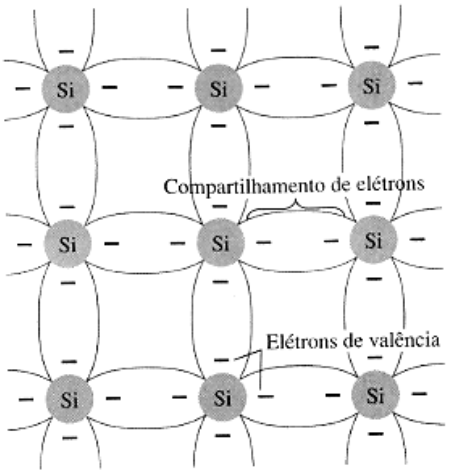
Propriedades elétricas dos materiais

Condutor (ex. Cobre) : **Existem elétrons livres que podem circular, e gerar correntes.**

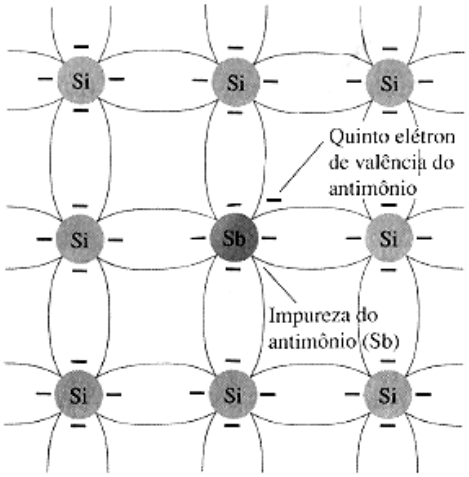
Isolante (ex. vidro): **eletrons não podem circular Não conduzem eletricidade.**

Semicondutor *intrínseco* ou puro (ex. Germânio, Silício):
A temperatura ambiente comporta-se approximadamente como um isolante
Mas, energia térmica pode produzir elétrons livres e lacunas (buracos, positivos),
portanto ocorre fluxo de corrente (portadores: eletrons (-) e lacunas (+))

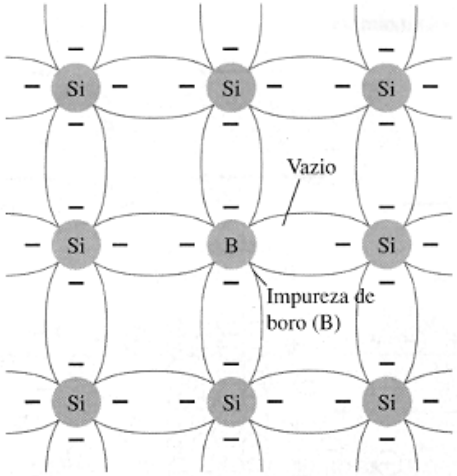




Ligação covalente do átomo de silício.



Impureza de antimônio no material do tipo *n*



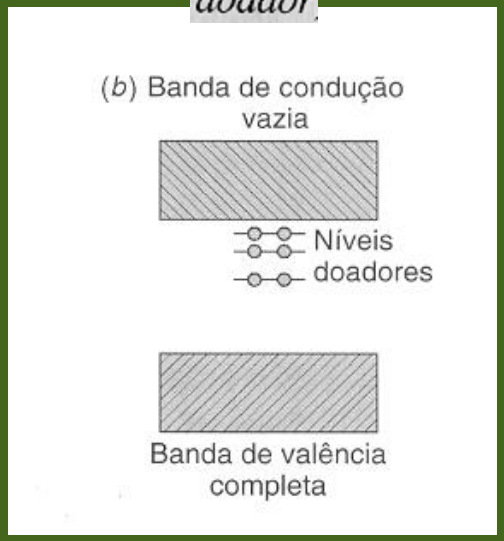
Impureza de boro no material do tipo *p*.

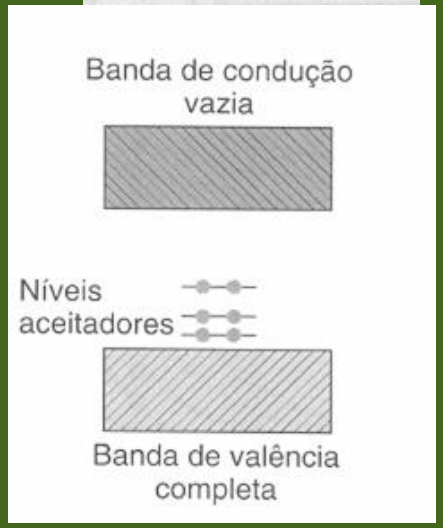
impurezas

cinco *elétrons de valência*

doador

impurezas com três elétrons de átomos aceitadores.





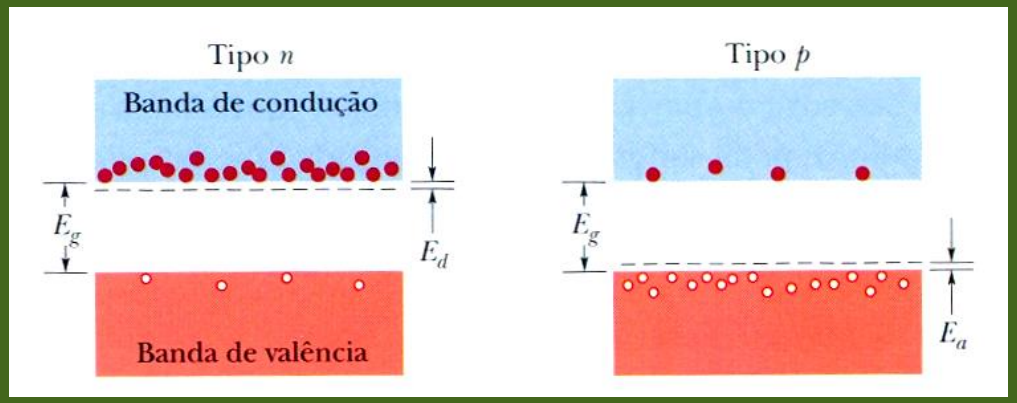
Propriedades elétricas dos materiais

Semicondutor *intrínseco* ou puro (ex. Germânio, Silício):
A temperatura ambiente comporta-se approximadamentecomo um isolante
Mas, energia térmica pode produzir elétrons livres e lacunas (buracos, positivos),
portanto ocorre fluxo de corrente (portadores: eletrons (-) e lacunas (+))

Dopagem de um semicondutor:
Pode-se aumentar a condutibilidade adicionando impurezas (semicondutor *extrínseco*)

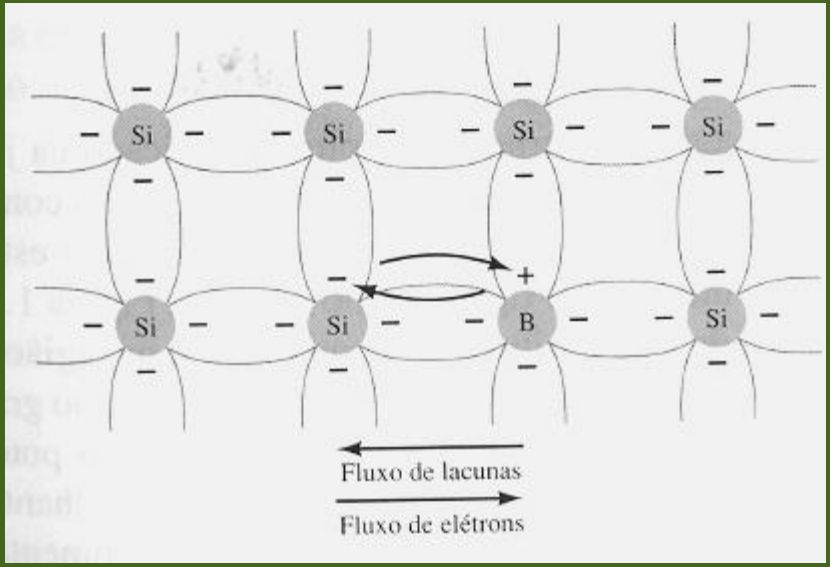
Átomos com mais eletrons (P, Sb):
fica um elétron extra,
impureza doadora, dopagem *n*

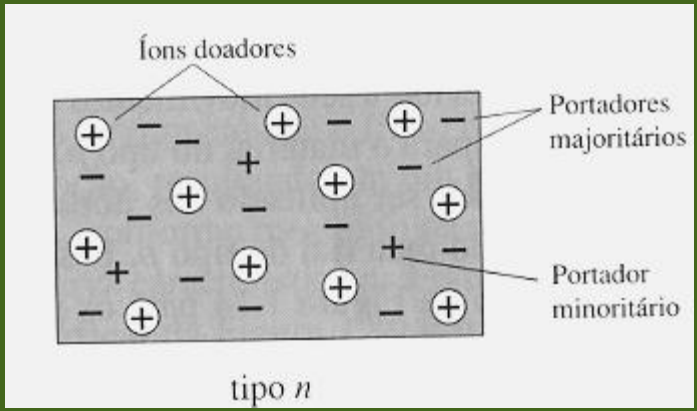
Átomos com menos eletrons (B,Al,Ga):
fica uma lacuna extra,
impureza receptora, dopagem *p*

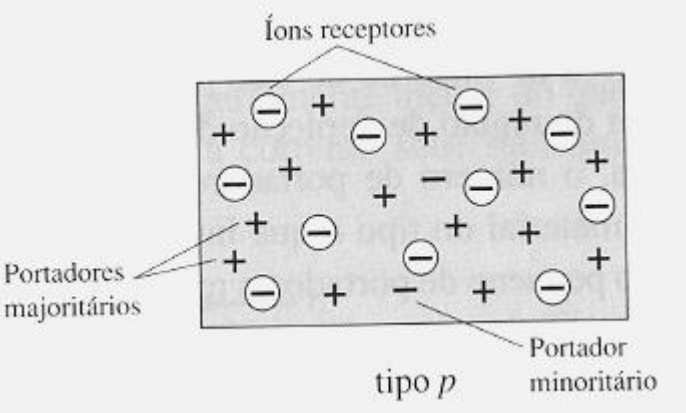


Malvino, *Eletrônica*, 4ta ed., vol. 1, Pearson, Brasil

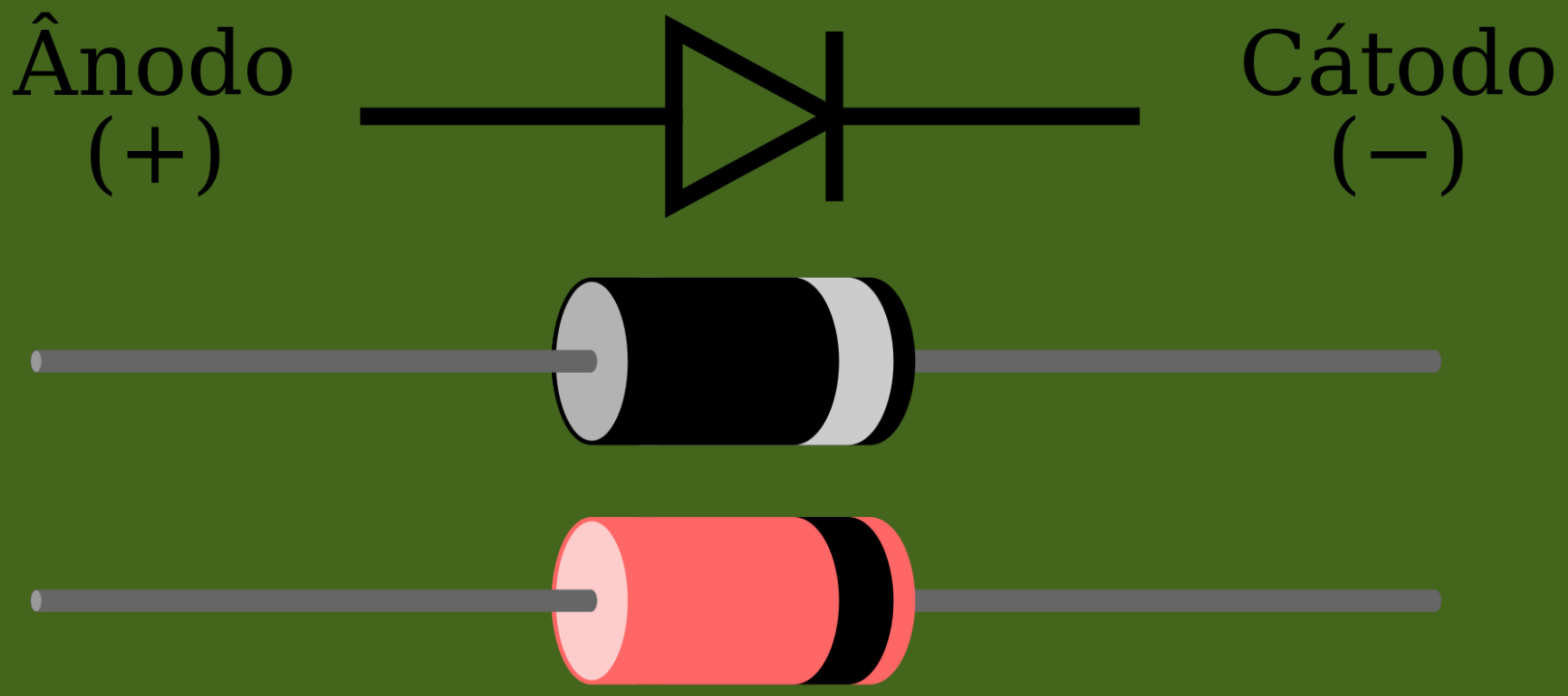
Sedra, *Microeletrônica*, 4ta ed., Pearson, Brasil

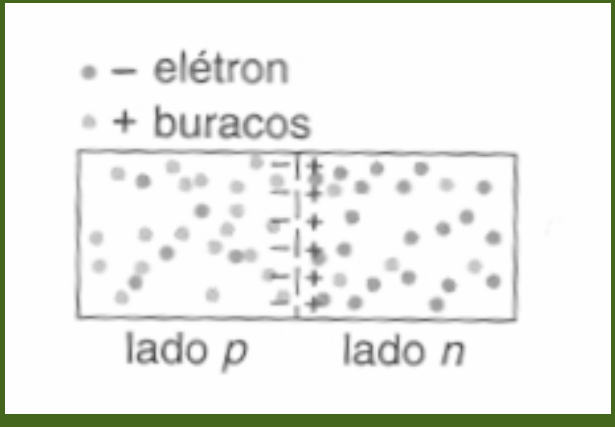

Si
Si
Si
Si
Si
Si
B
Si
Fluxo de lacunas
Fluxo de elétrons

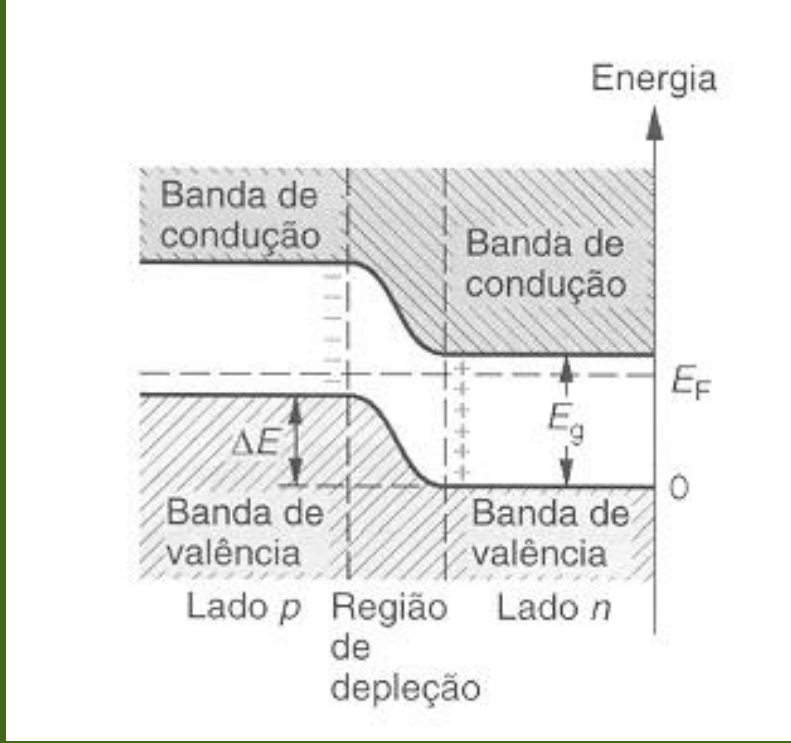

Íons doadores
Portadores majoritários
Portador minoritário
tipo *n*

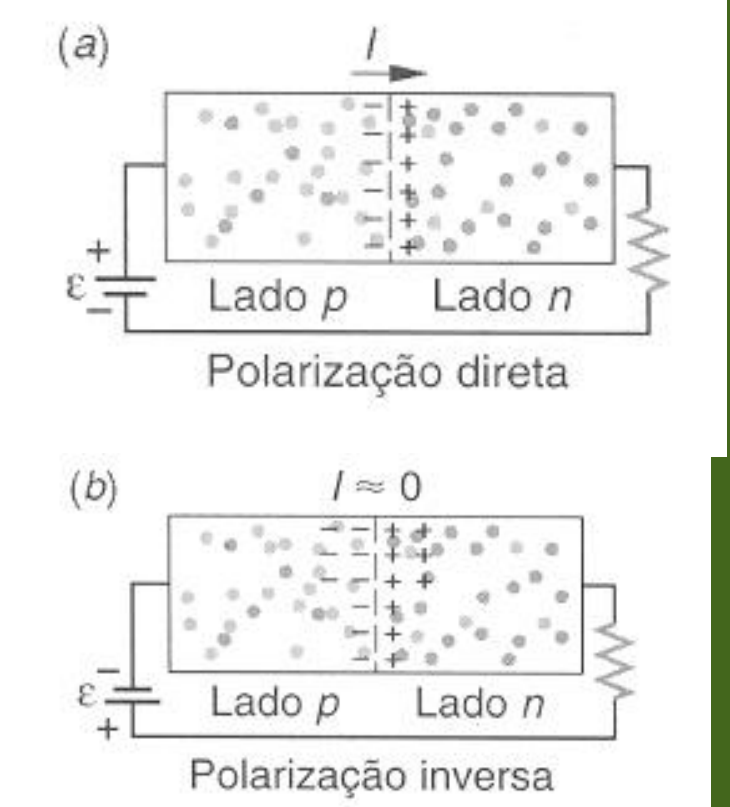

Íons receptores
Portadores majoritários
Portador minoritário
tipo *p*

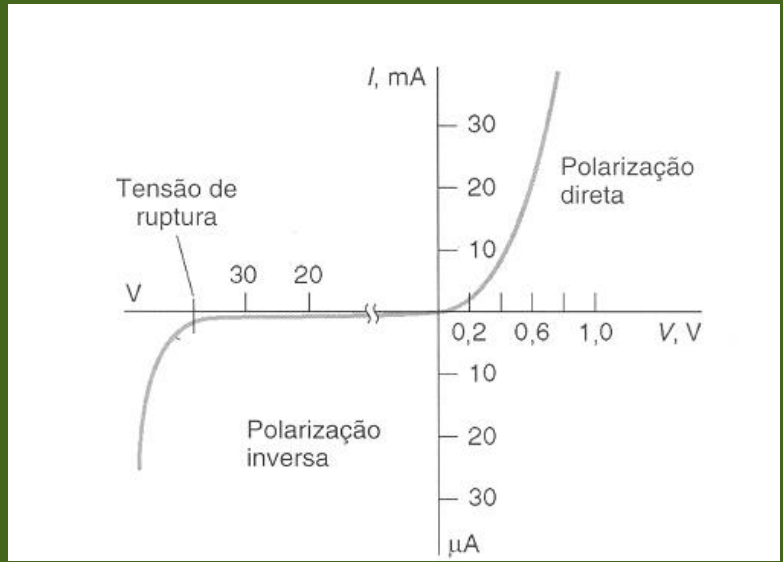
Diode

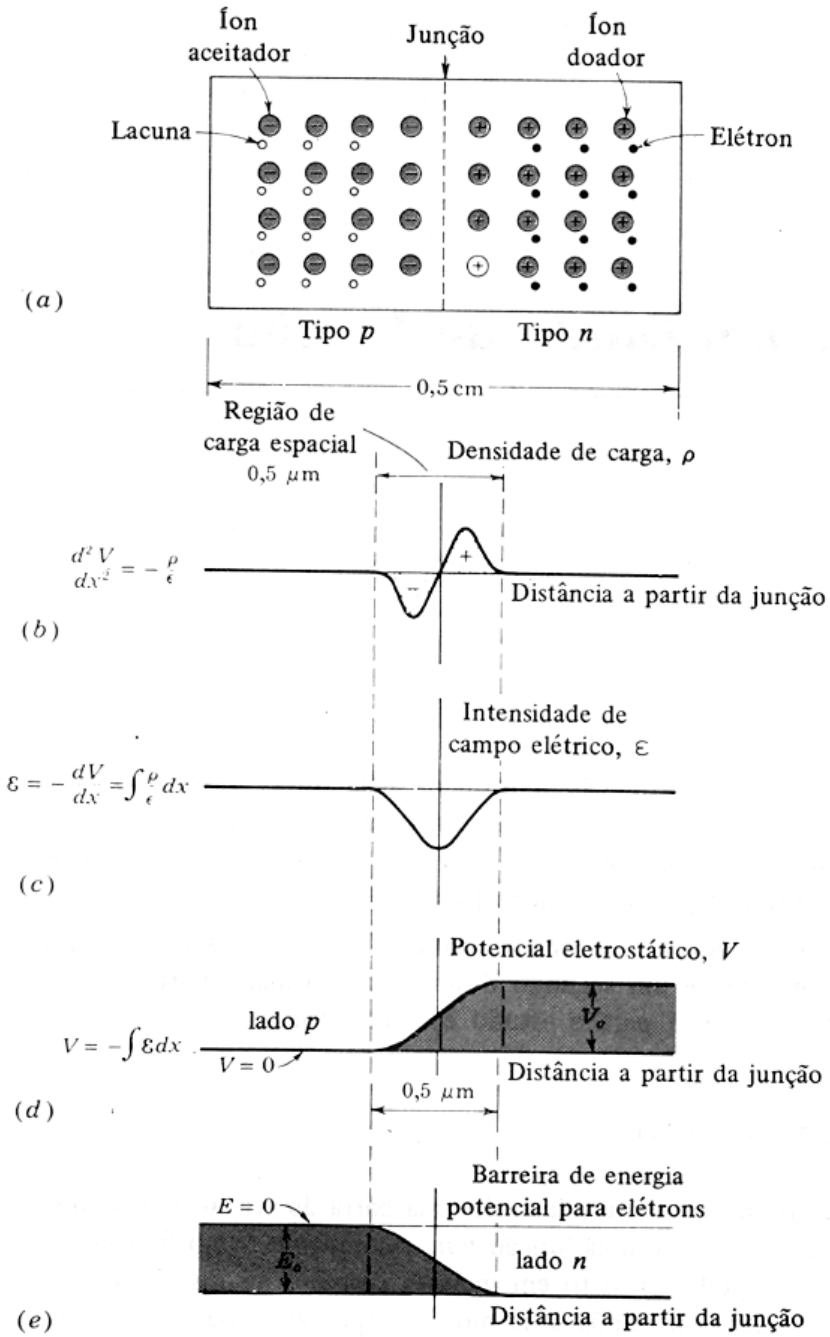



– elétron
+ buracos
lado p
lado n

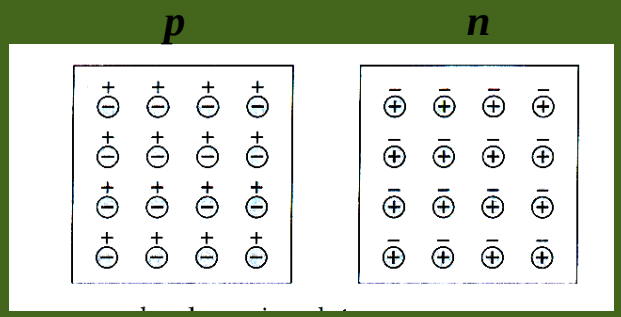

Energia
Banda de condução
Banda de condução
E_F
E_g
ΔE
0
Banda de valência
Banda de valência
Lado p
Região de depleção
Lado n

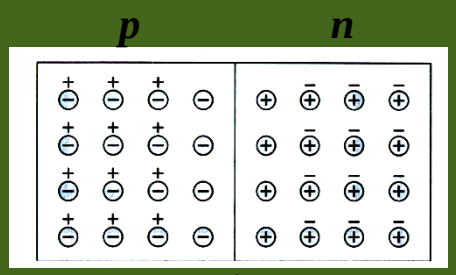

(a)
I
ε
Lado p
Lado n
Polarização direta
(b)
I ≈ 0
ε
Lado p
Lado n
Polarização inversa

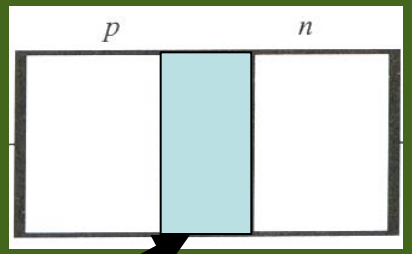

I, mA
30
20
10
Tensão de ruptura
V
30
20
Polarização direta
0,2
0,6
1,0
V, V
10
20
30
μA
Polarização inversa


Íon aceitador
Junção
Íon doador
Lacuna
Elétron
(a)
Tipo p
Tipo n
0,5 cm
Região de carga espacial
0,5 μm
Densidade de carga, ρ
$\frac{d^2V}{dx^2} = -\frac{\rho}{\epsilon}$
Distância a partir da junção
(b)
Intensidade de campo elétrico, ε
$\varepsilon = -\frac{dV}{dx} = \int \frac{\rho}{\epsilon} dx$
(c)
Potencial eletrostático, V
lado p
$V = -\int \varepsilon dx$
$V = 0$
V_o
Distância a partir da junção
0,5 μm
(d)
Barreira de energia potencial para elétrons
$E = 0$
E_o
lado n
Distância a partir da junção
(e)

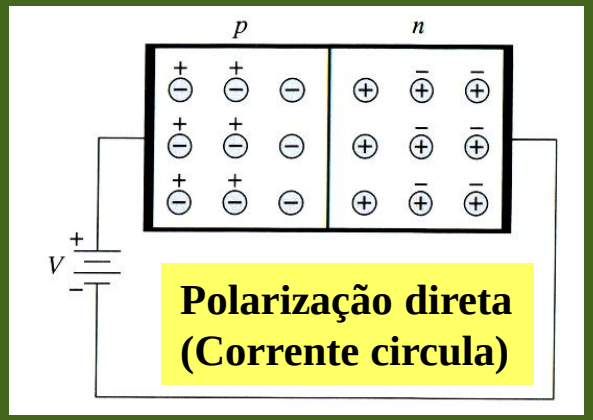
Junção *p-n*



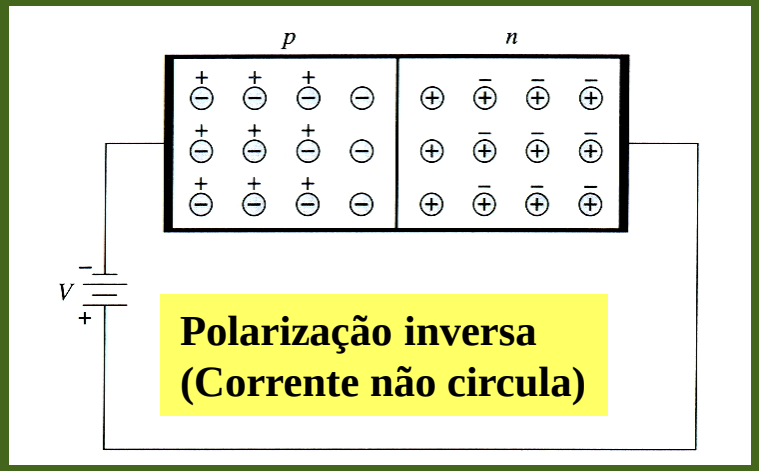




Camada de depleção
(barrera de potencial 0.3 eV Ge, 0.7 eV Si)

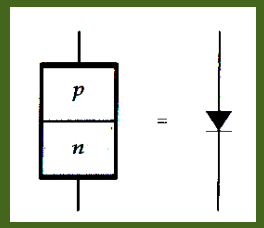


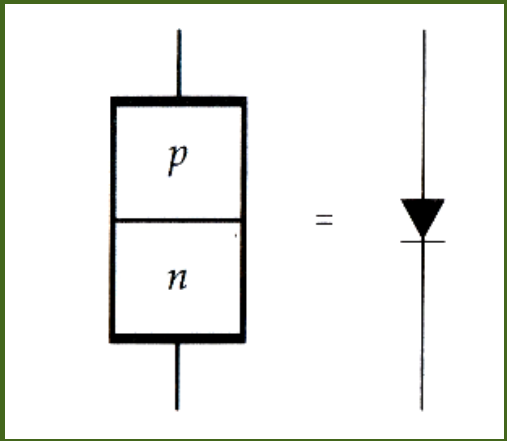
Polarização direta
(Corrente circula)



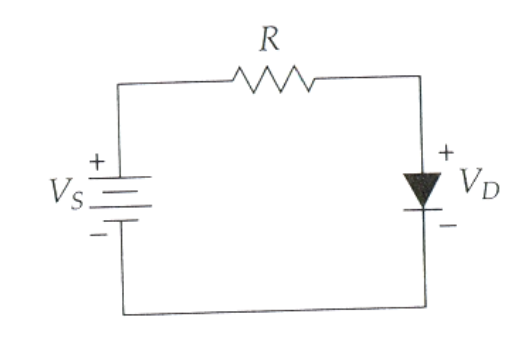
Polarização inversa
(Corrente não circula)

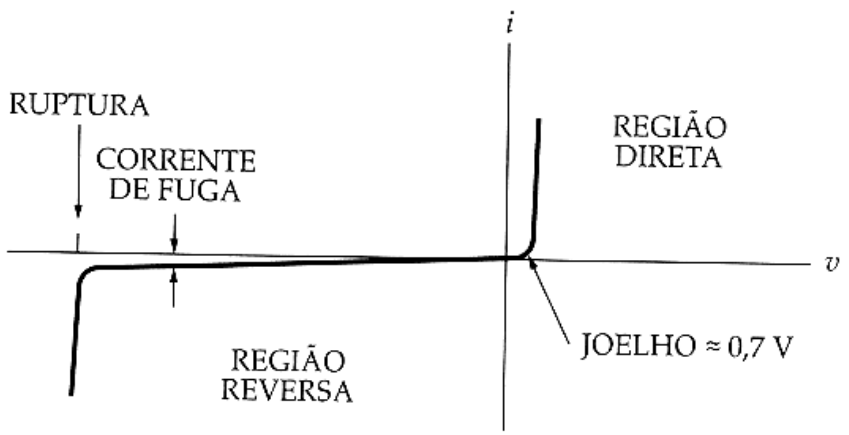
Diodo
(contração “dois –eletrodos”)





polarização direta.



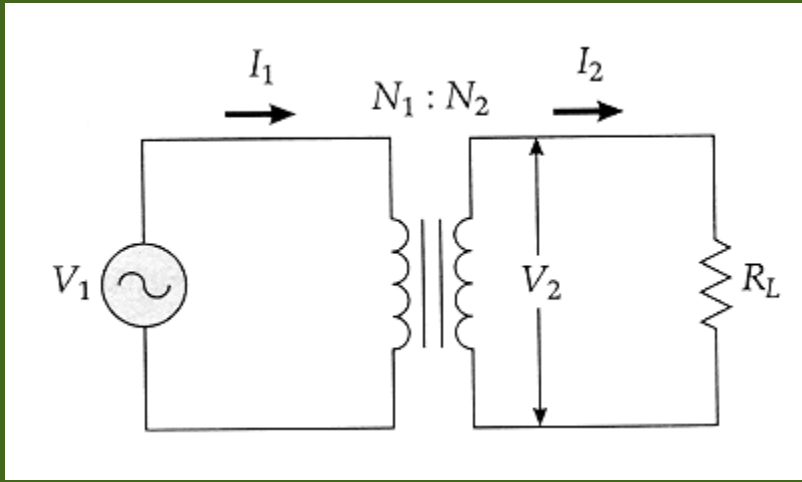


A curva do diodo.

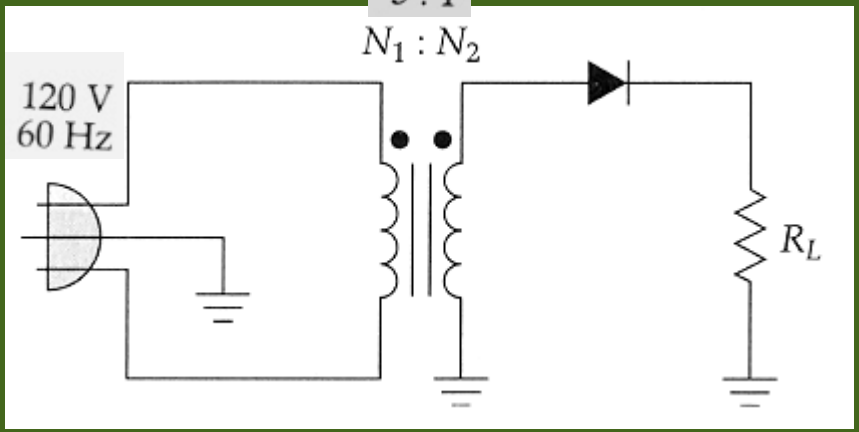
Fontes e retificação

O transformador com carga.

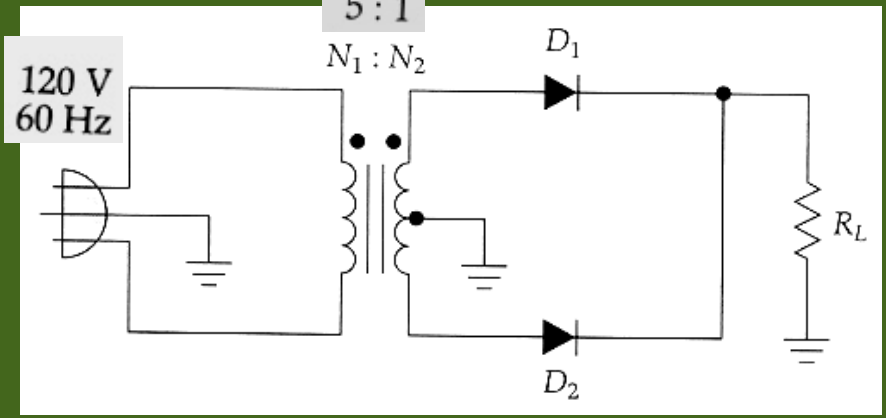
$$V_2 = \frac{N_2}{N_1} V_1$$

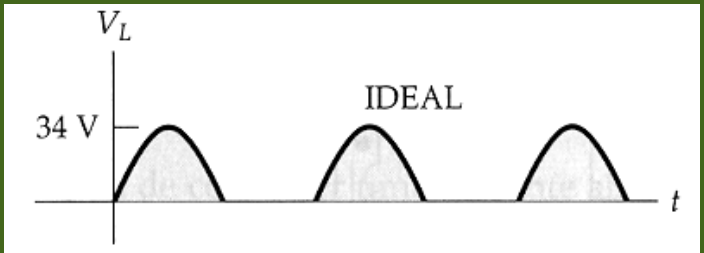


O retificador de meia onda.

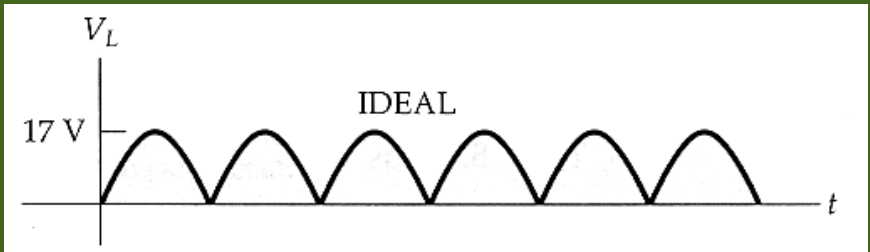


O retificador de onda completa com tomada central.



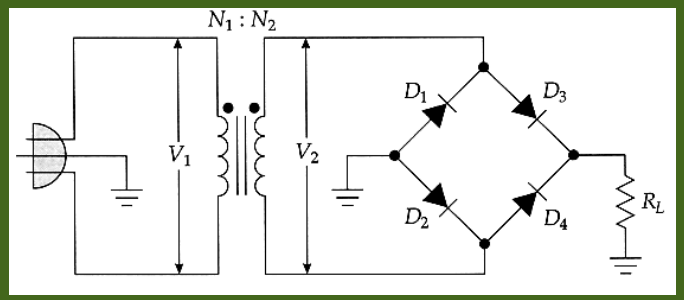


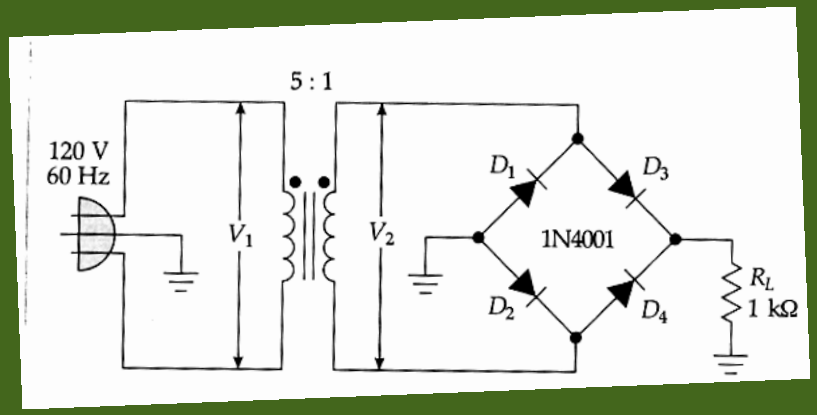
O sinal de meia onda.



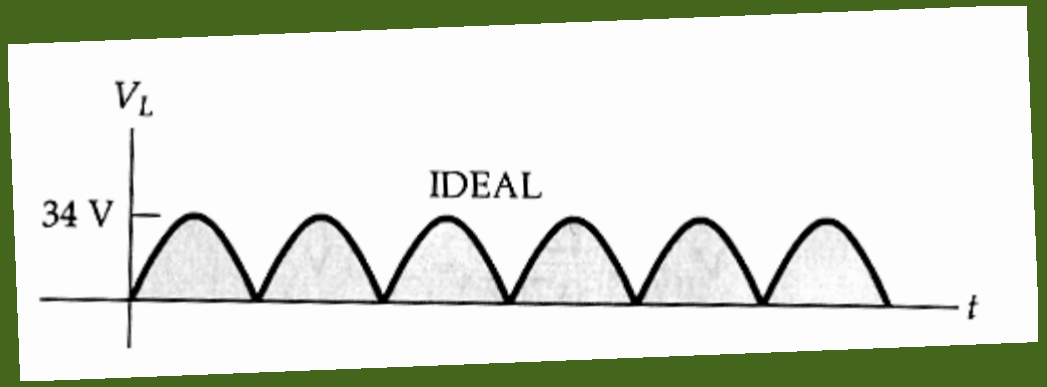
O sinal de onda completa.

O retificador de onda completa em ponte.

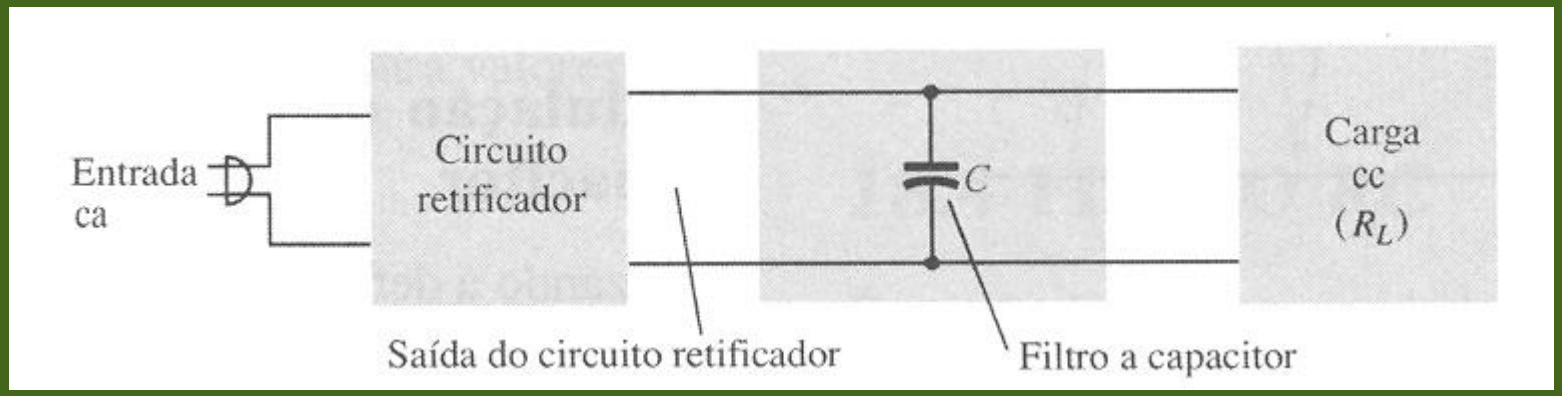


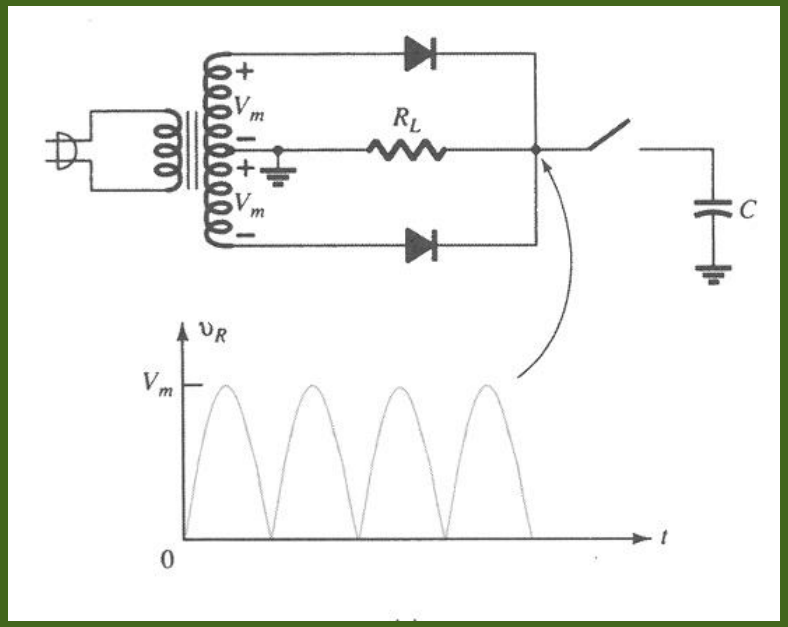


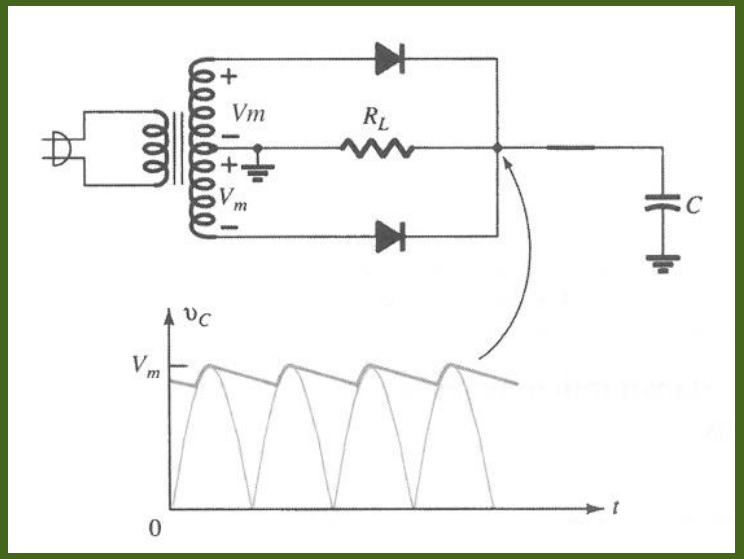
$$V_p = 34\text{ V} - 2(0{,}7\text{ V}) = 32{,}6\text{ V}$$

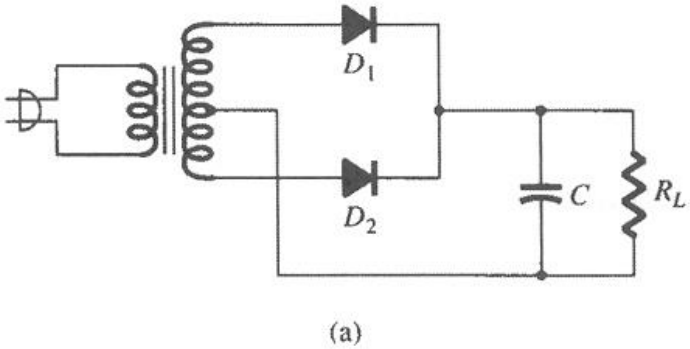


O sinal de onda completa.

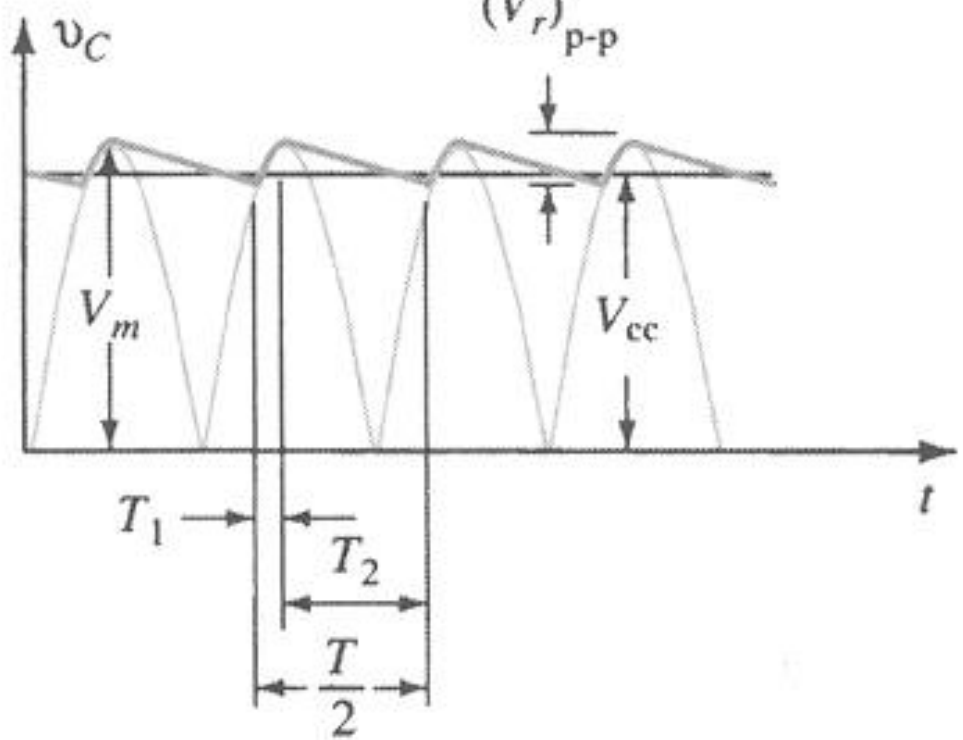

Entrada
ca
Circuito
retificador
C
Carga
cc
(R_L)
Saída do circuito retificador
Filtro a capacitor

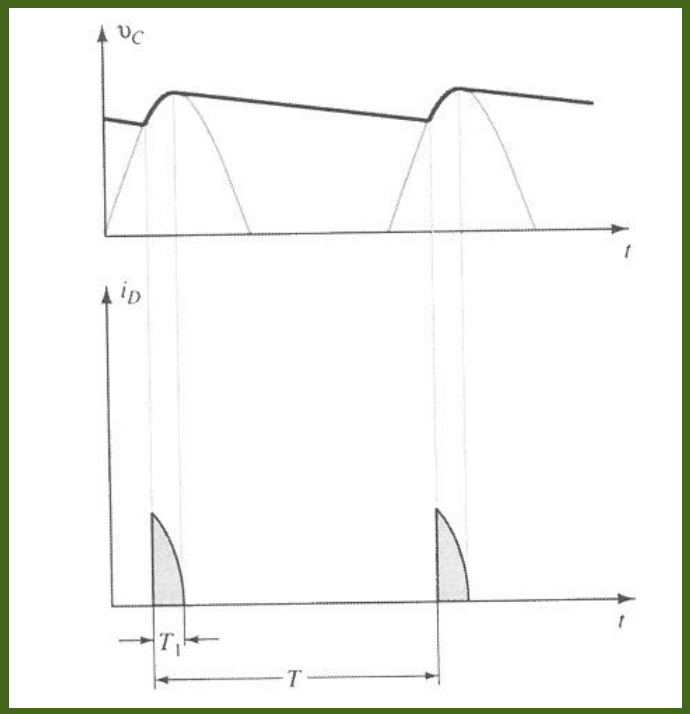

+
V_m
−
+
V_m
−
R_L
C
v_R
V_m
0
t

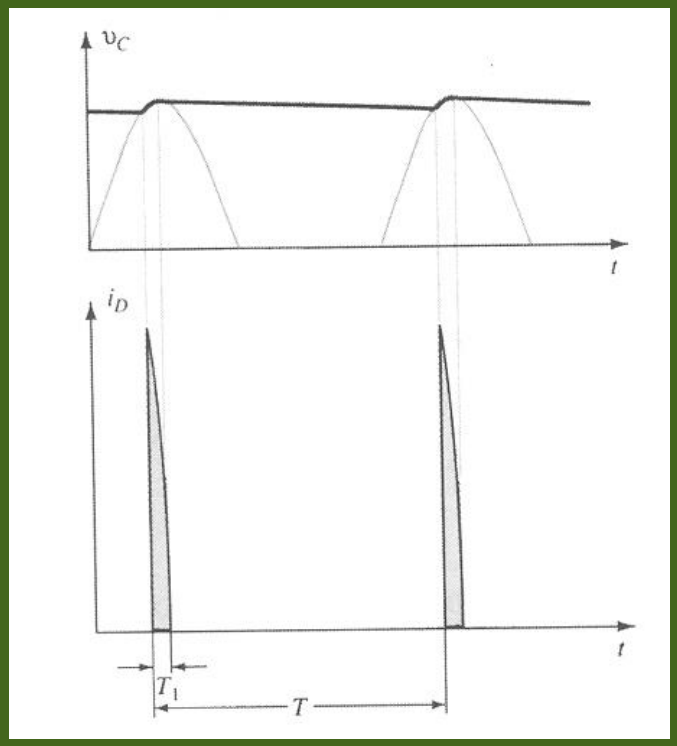

+
Vm
−
+
V_m
−
R_L
C
v_C
V_m
0
t



(a)

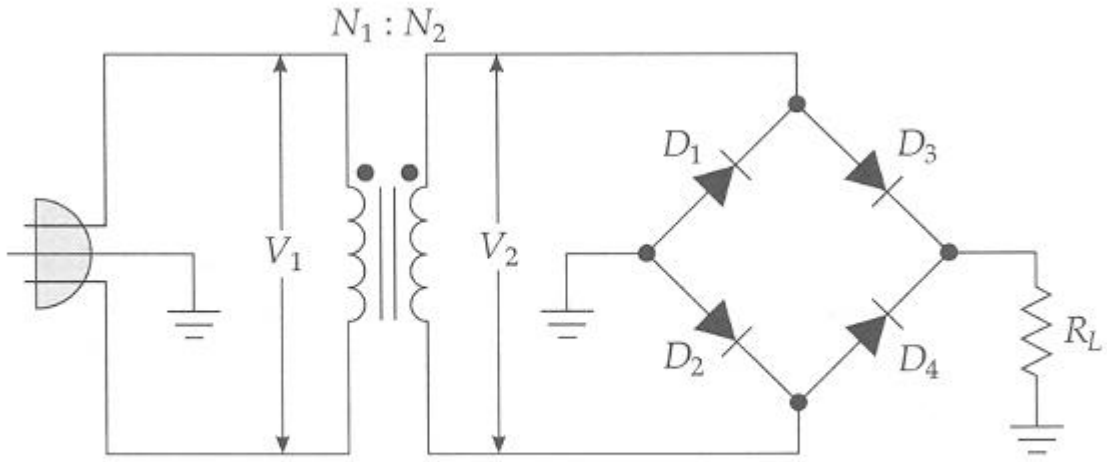




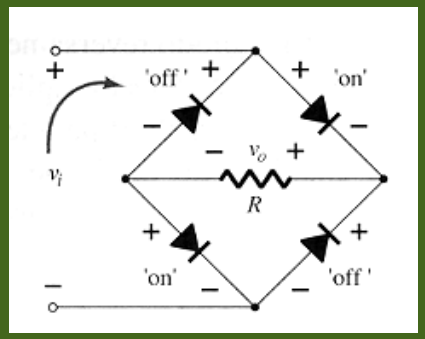


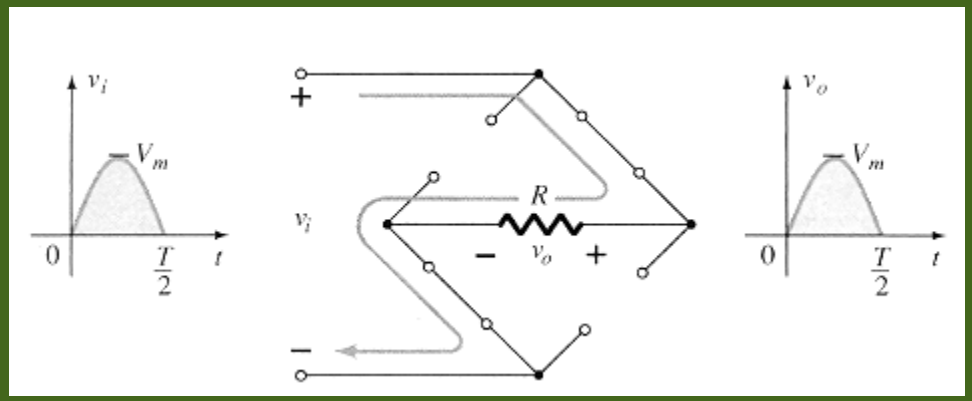
Tensão de saída e formas de onda da corrente no diodo

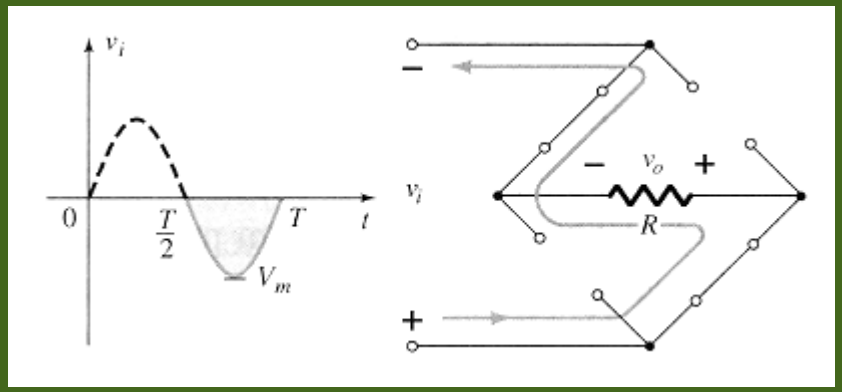
(a) C pequeno; (b) C alto.

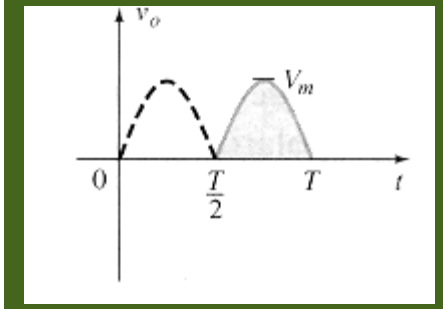


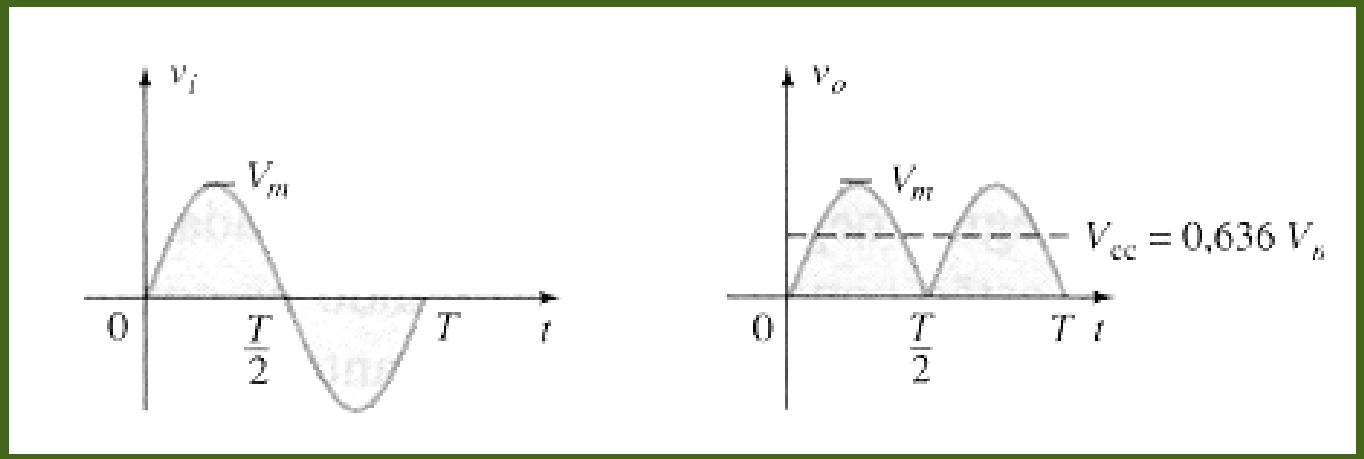
O retificador de onda completa em ponte.

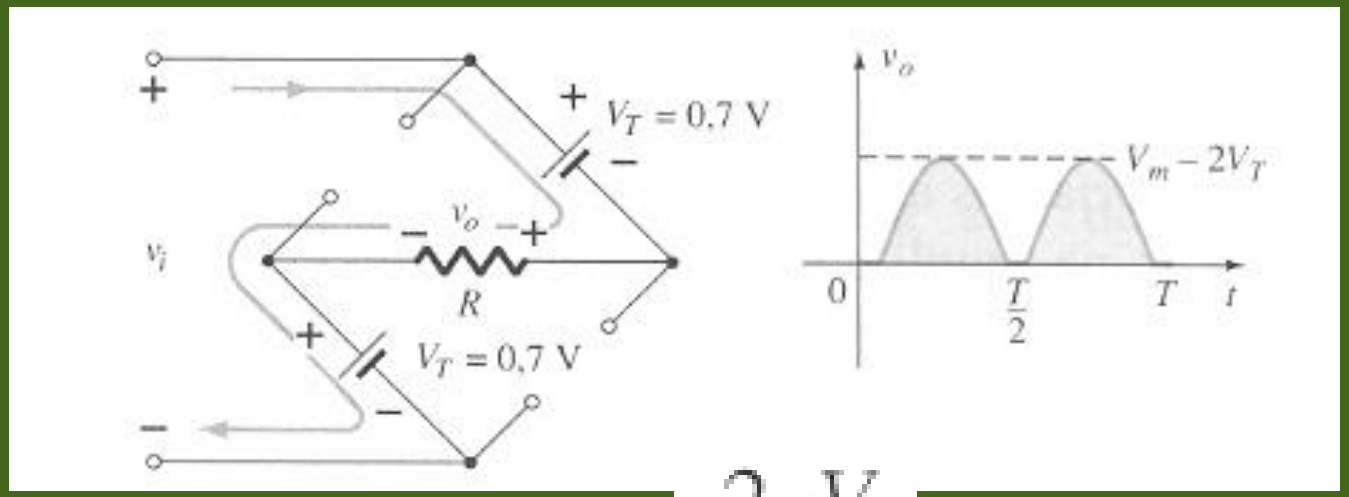

'off'
'on'
'on'
'off'
v_i
v_o
R


v_i
V_m
0
$\frac{T}{2}$
t
R
v_o

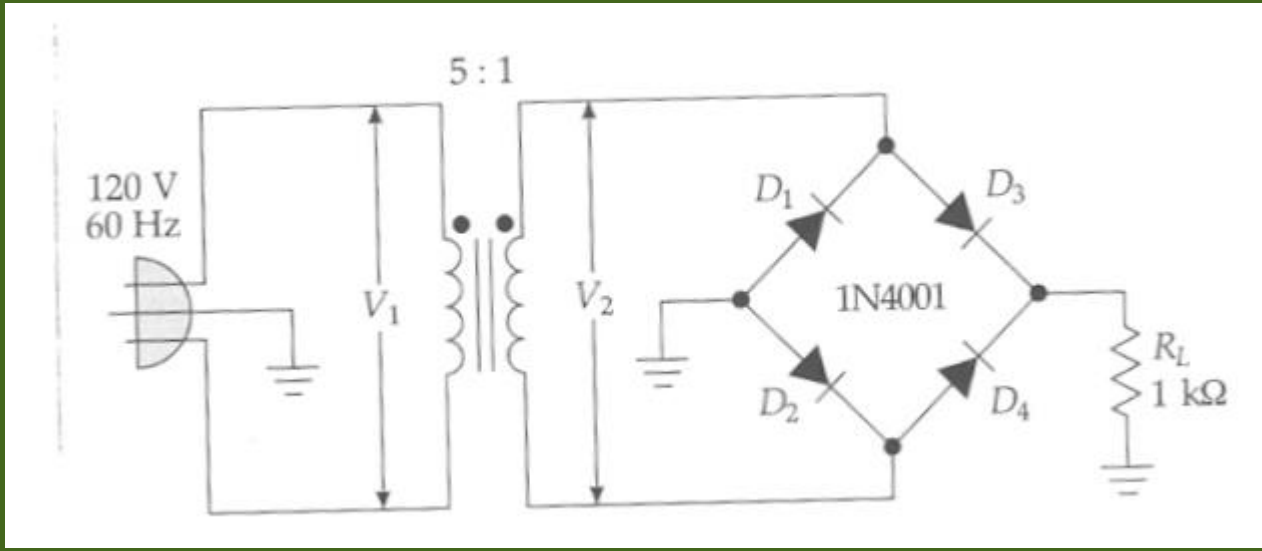

v_i
0
$\frac{T}{2}$
T
t
V_m
v_o
R


v_o
V_m
0
$\frac{T}{2}$
T
t

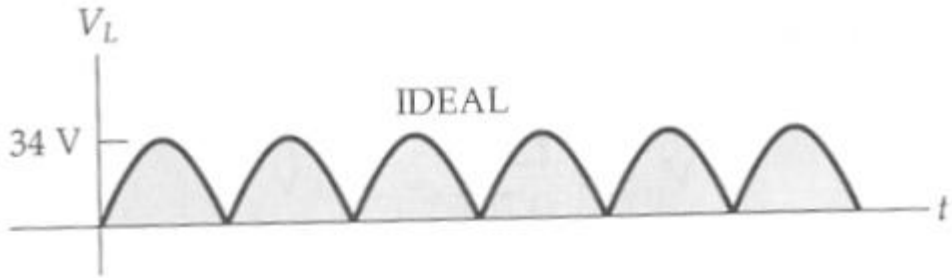

v_i
V_m
0
$\frac{T}{2}$
T
t
v_o
V_m
$V_{cc} = 0{,}636\ V_s$



$2\ V_T$

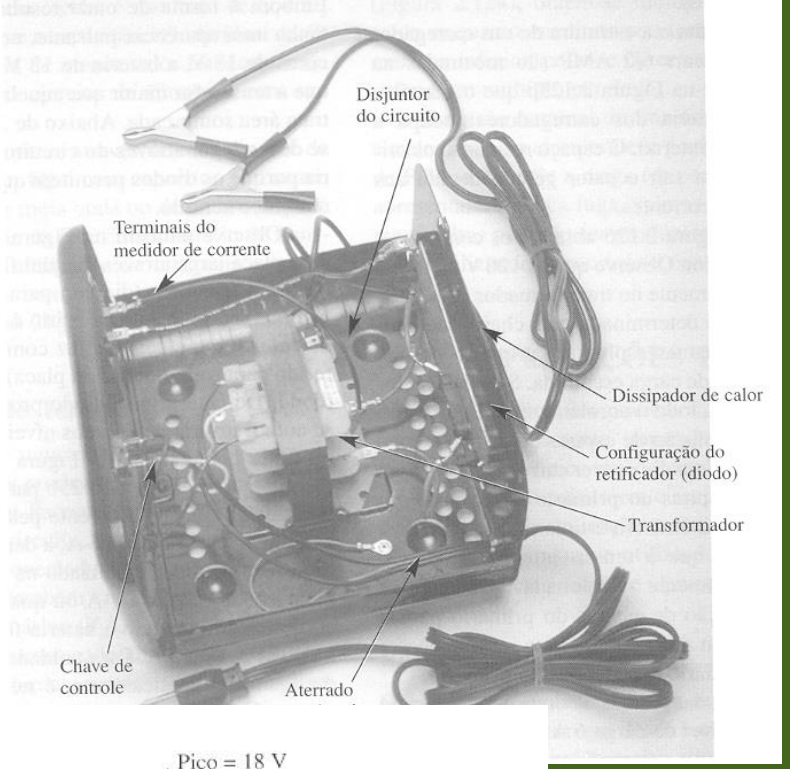


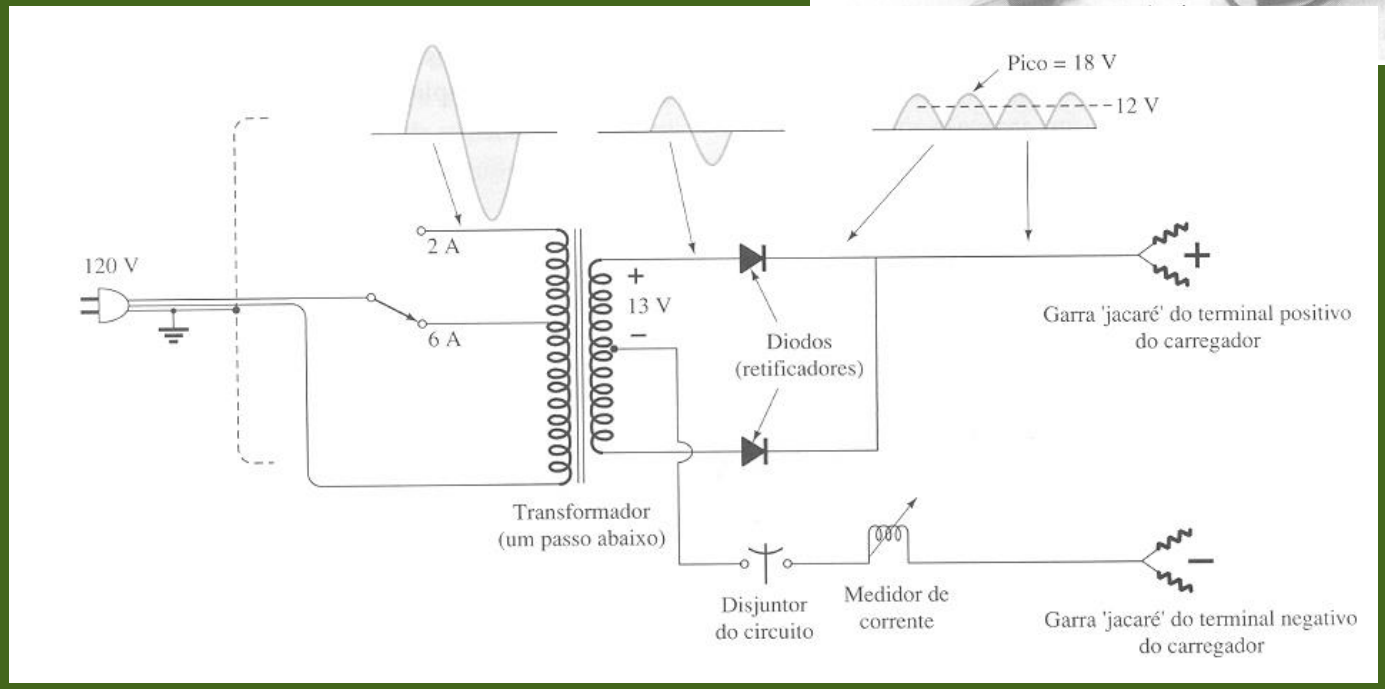
$$V_p = 34\text{ V} - 2(0{,}7\text{ V}) = 32{,}6\text{ V}$$



O sinal de onda completa.

Carregador de bateria





End!!!