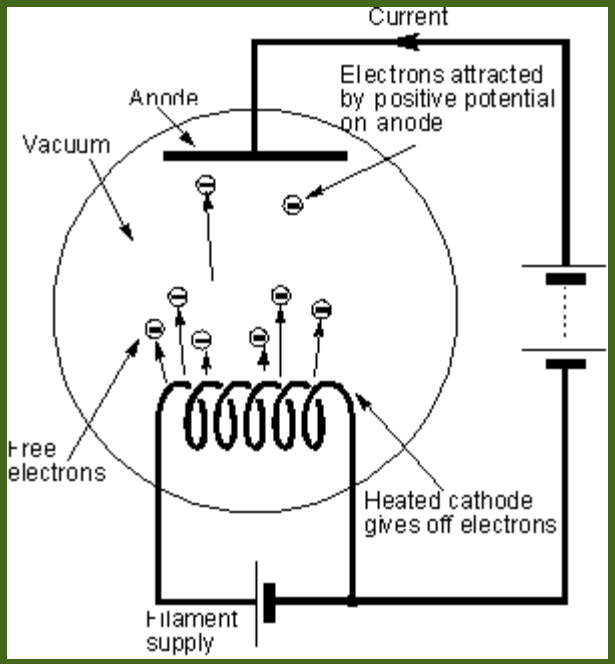
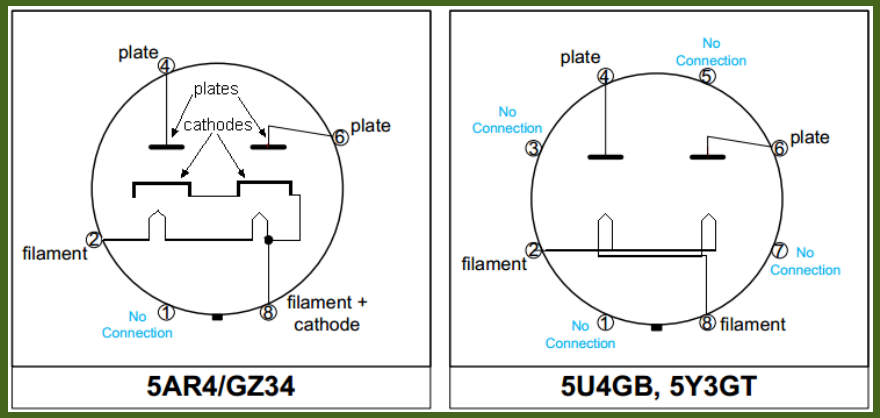
Válvulas,
Semicondutores e
Fontes de alimentaçao.

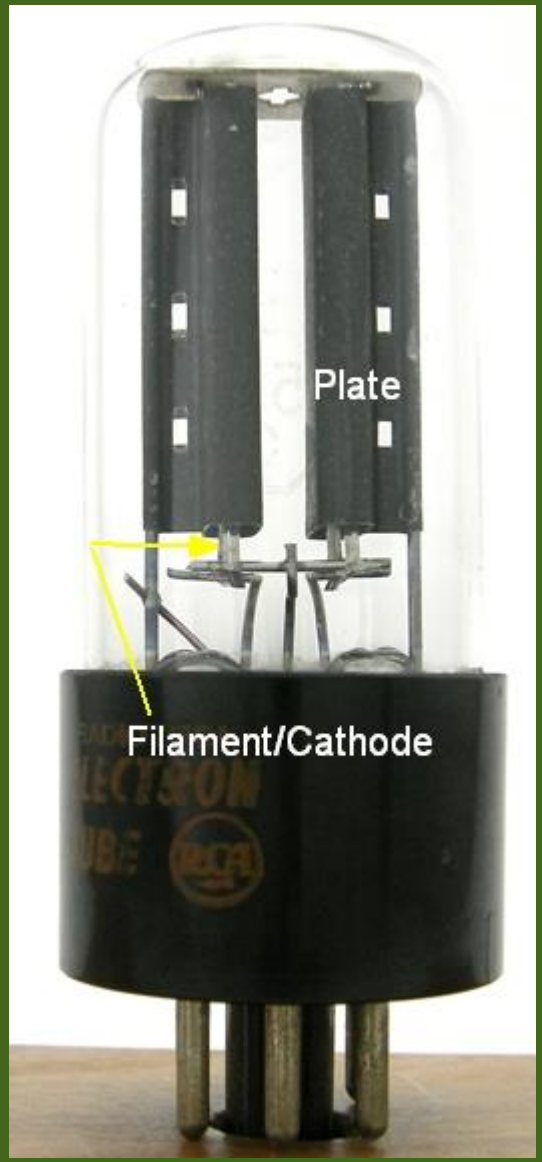
Diodos, junçoes PN

Vacuum tubes (válvulas)

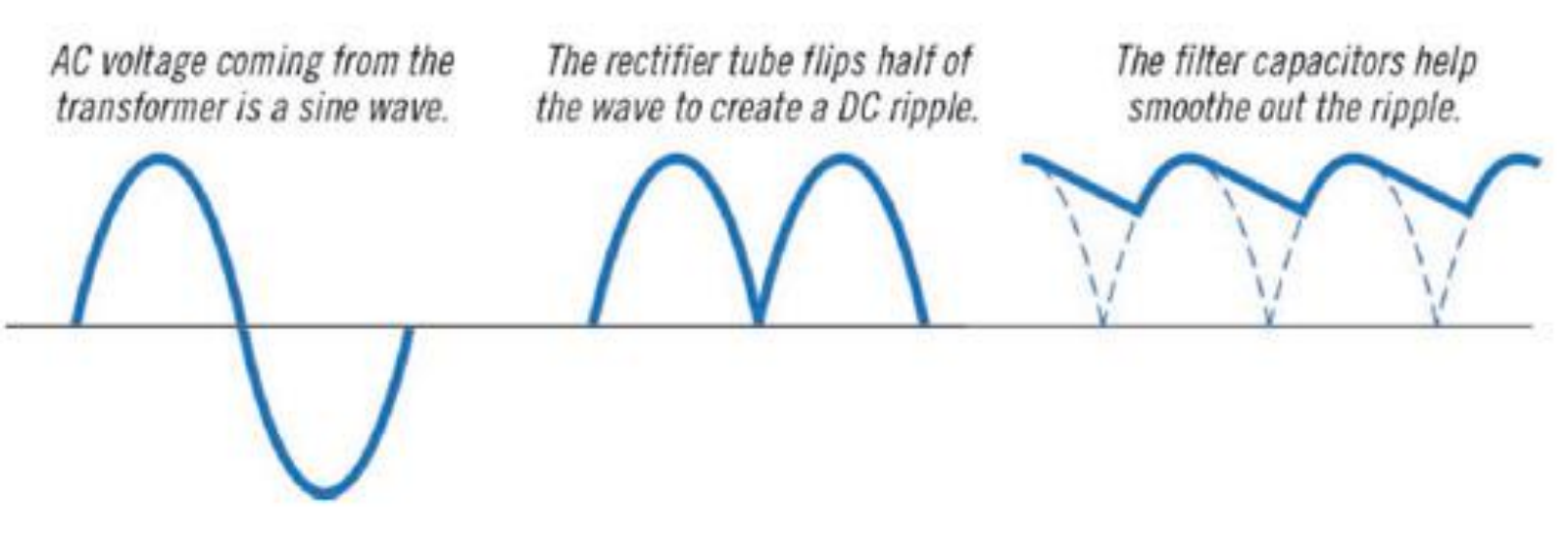
Vacuum Tubes (Valvulas)
Diodo



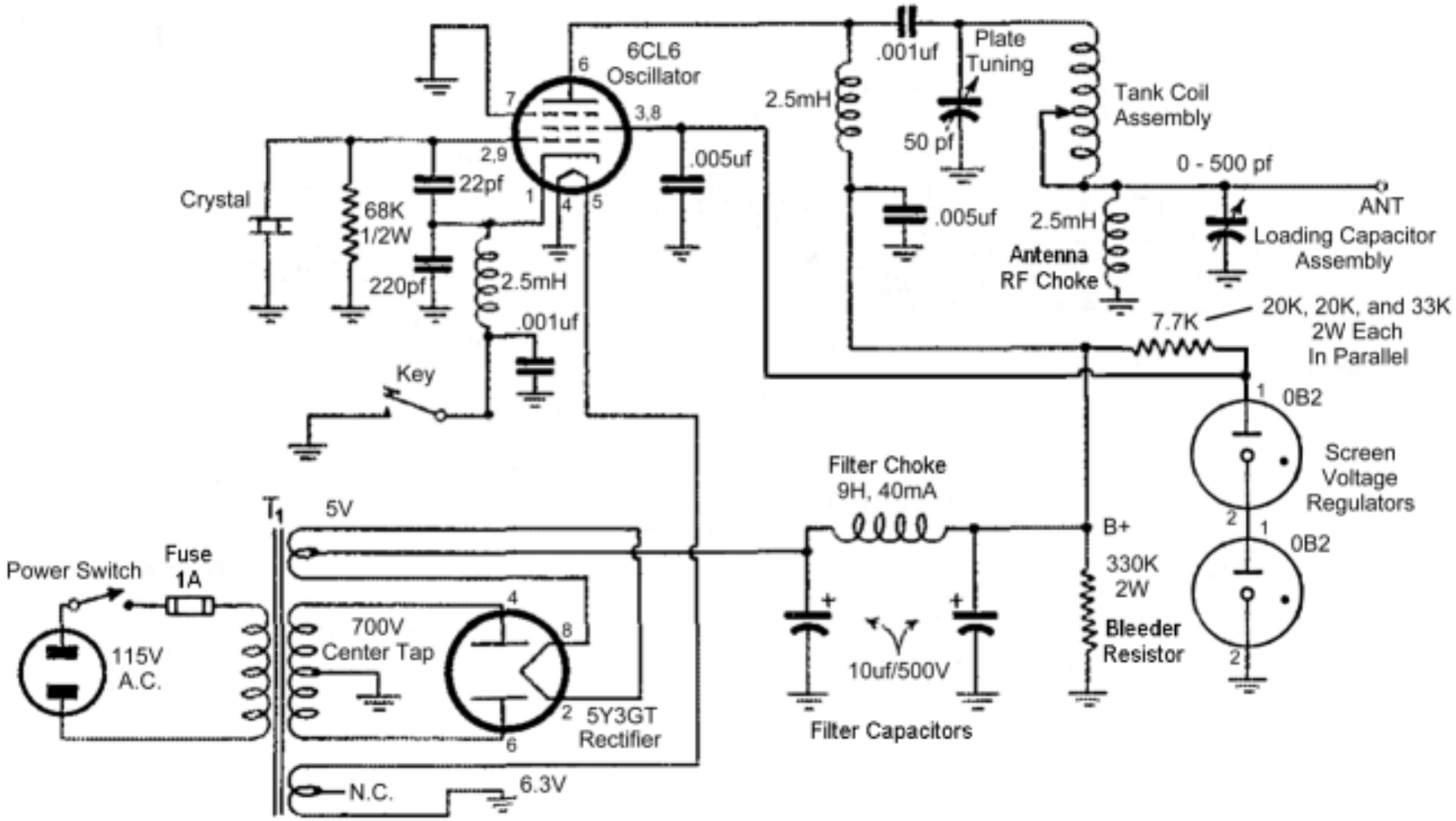


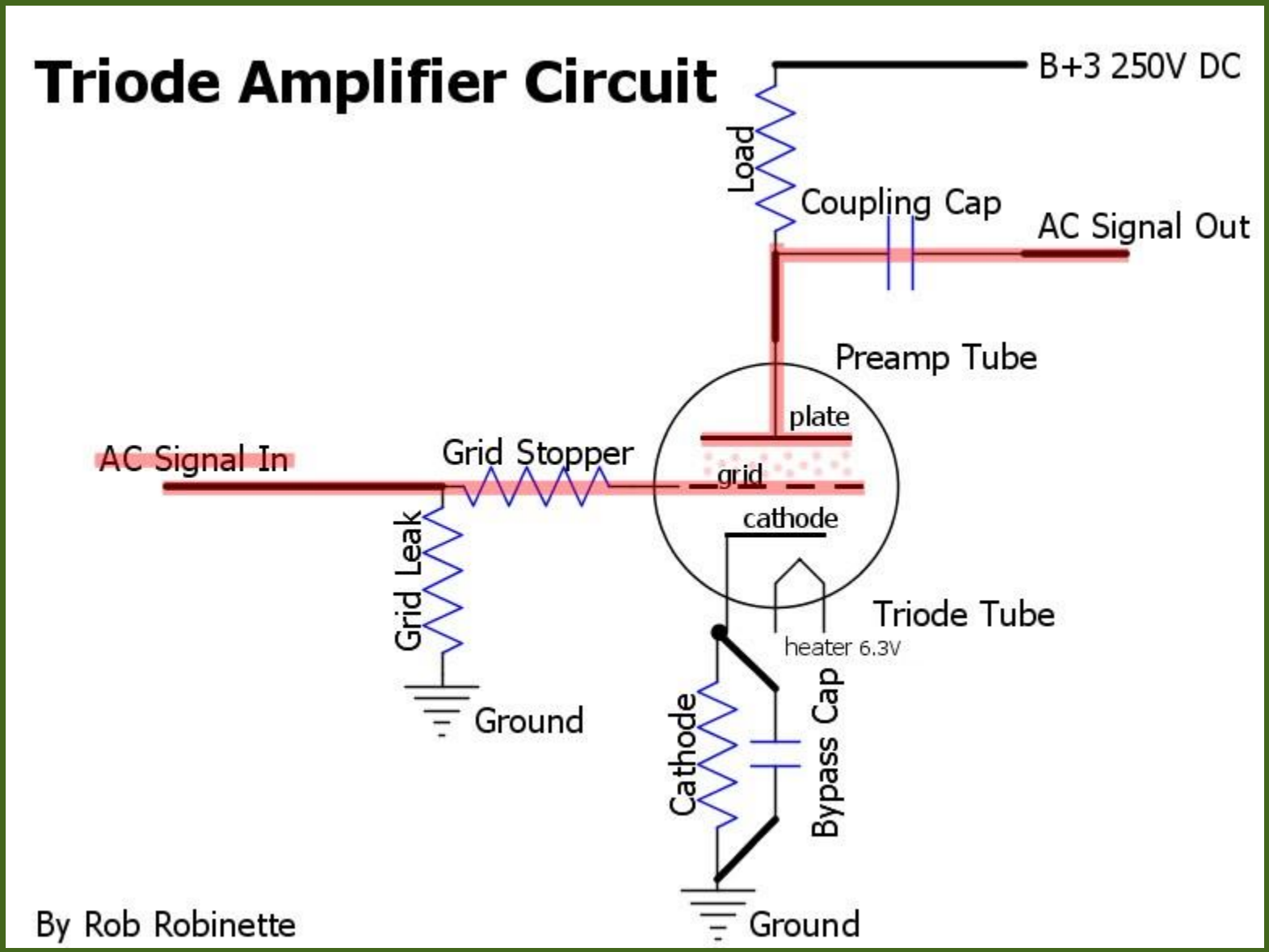


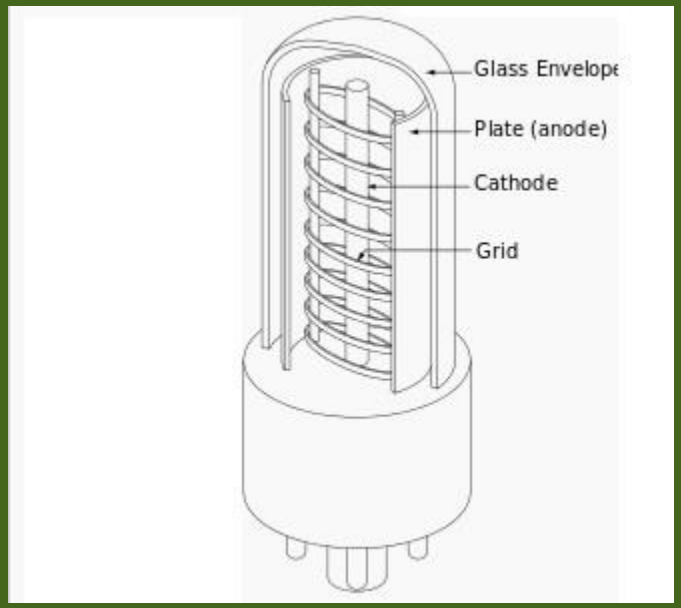
5Y3GT Rectifier

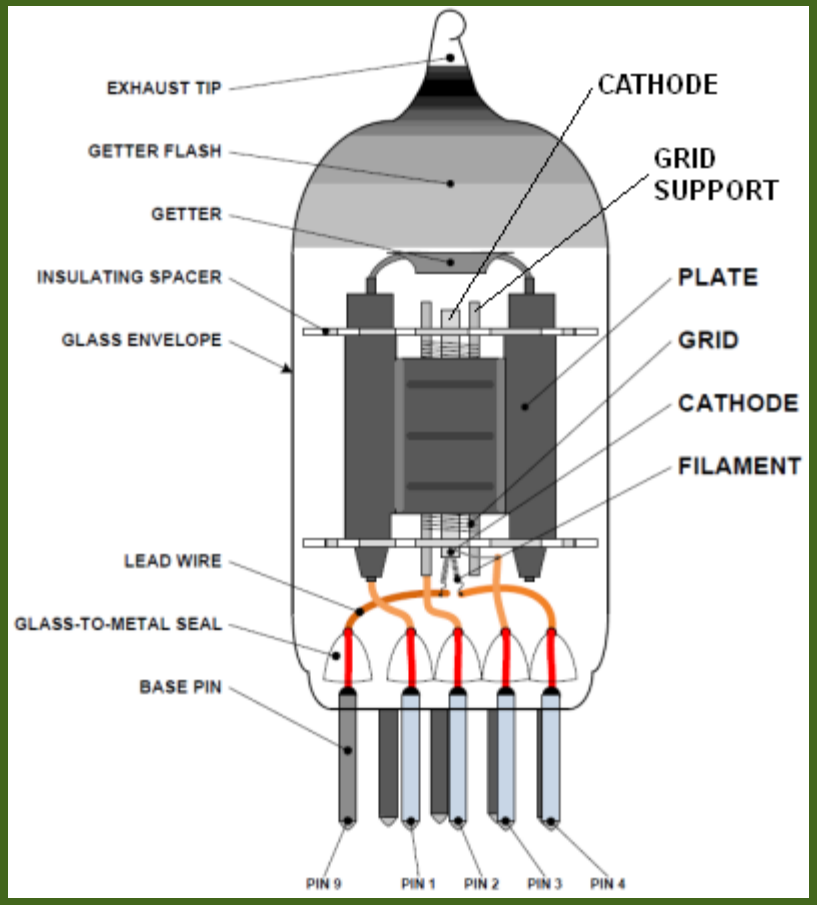

AC voltage coming from the transformer is a sine wave.
The rectifier tube flips half of the wave to create a DC ripple.
The filter capacitors help smoothe out the ripple.

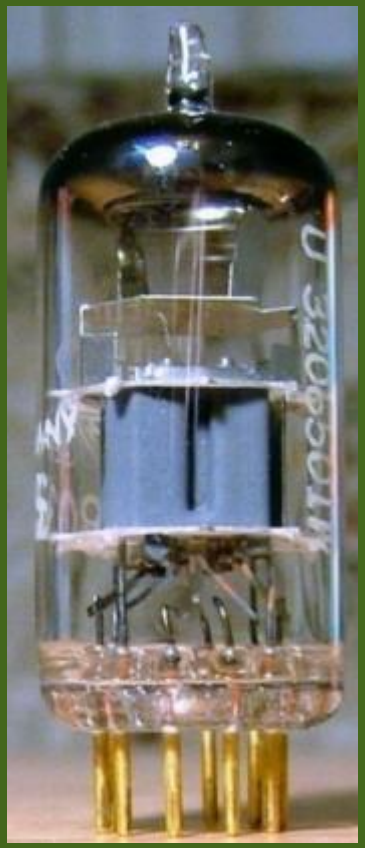
AA8V/W8EXI 6CL6 One-Tube Transmitter



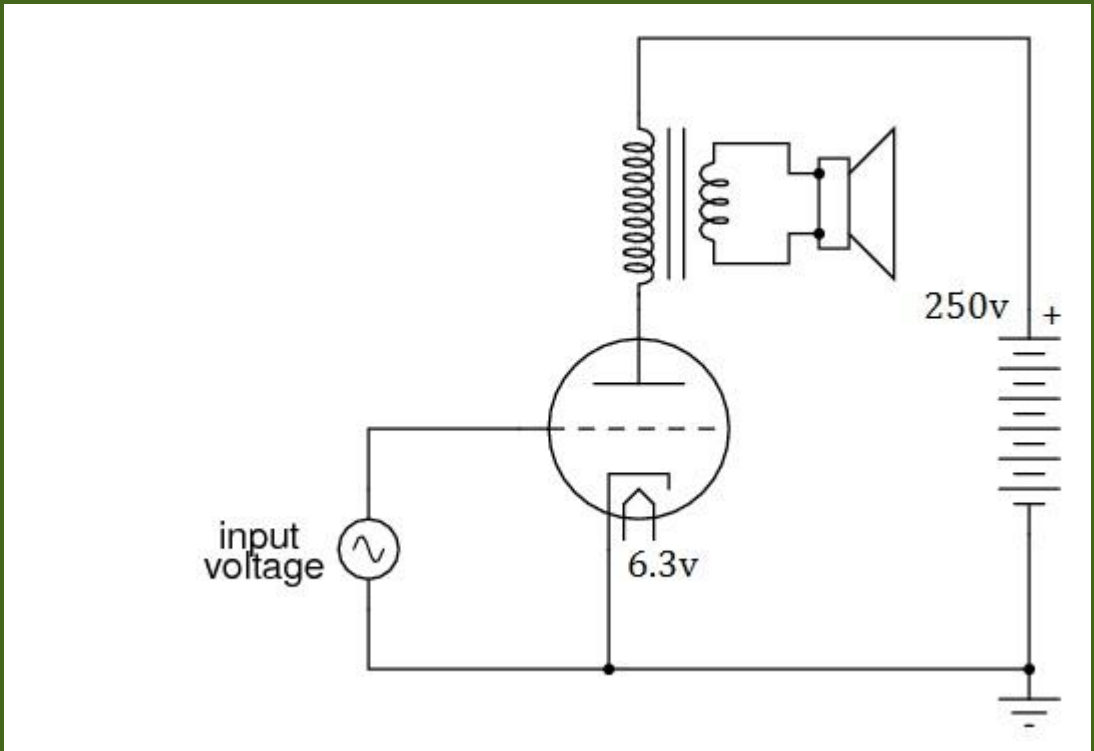

Triode Amplifier Circuit
B+3 250V DC
Load
Coupling Cap
AC Signal Out
Preamp Tube
plate
AC Signal In
Grid Stopper
grid
cathode
Grid Leak
Triode Tube
heater 6.3V
Ground
Cathode
Bypass Cap
Ground
By Rob Robinette


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:

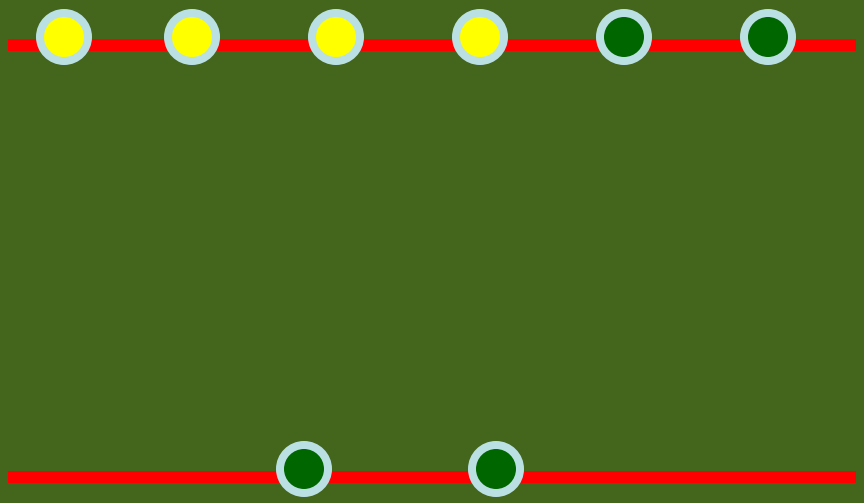
Vacuum tubes are still practical alternatives to solid-state devices in generating high power at radio frequencies (Klystron)

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

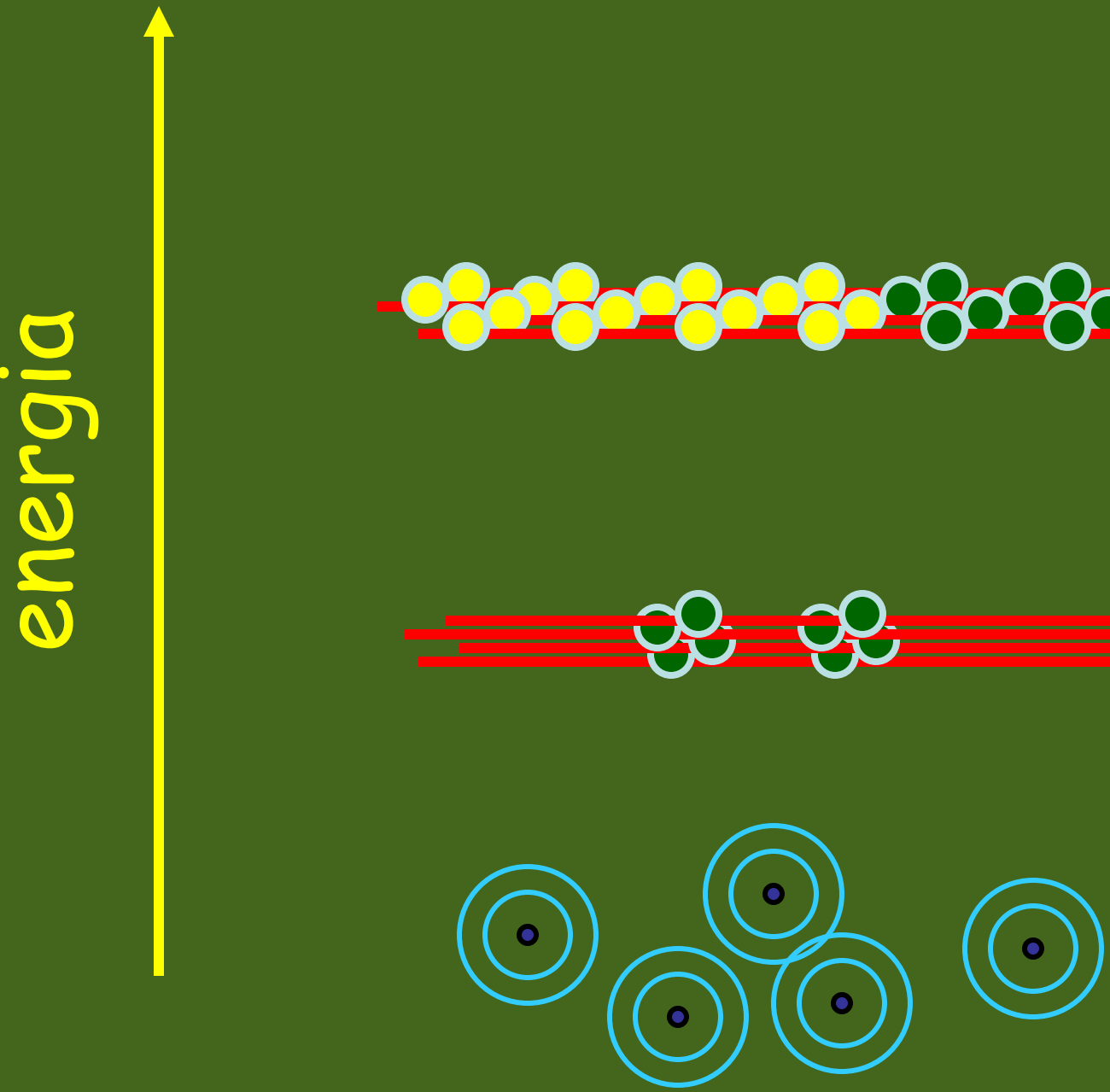
Semiconductors

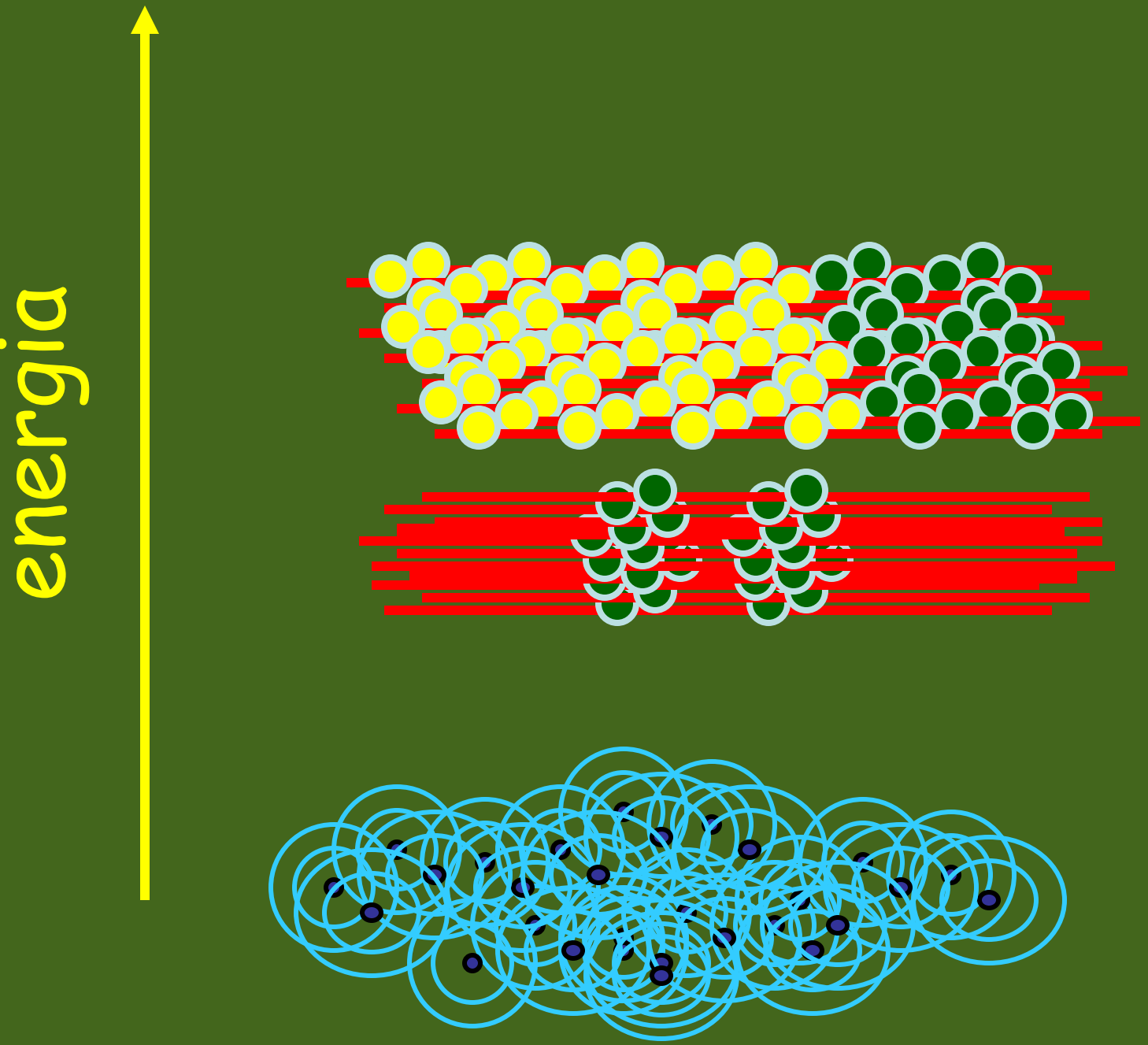
$s^2\ p^2$

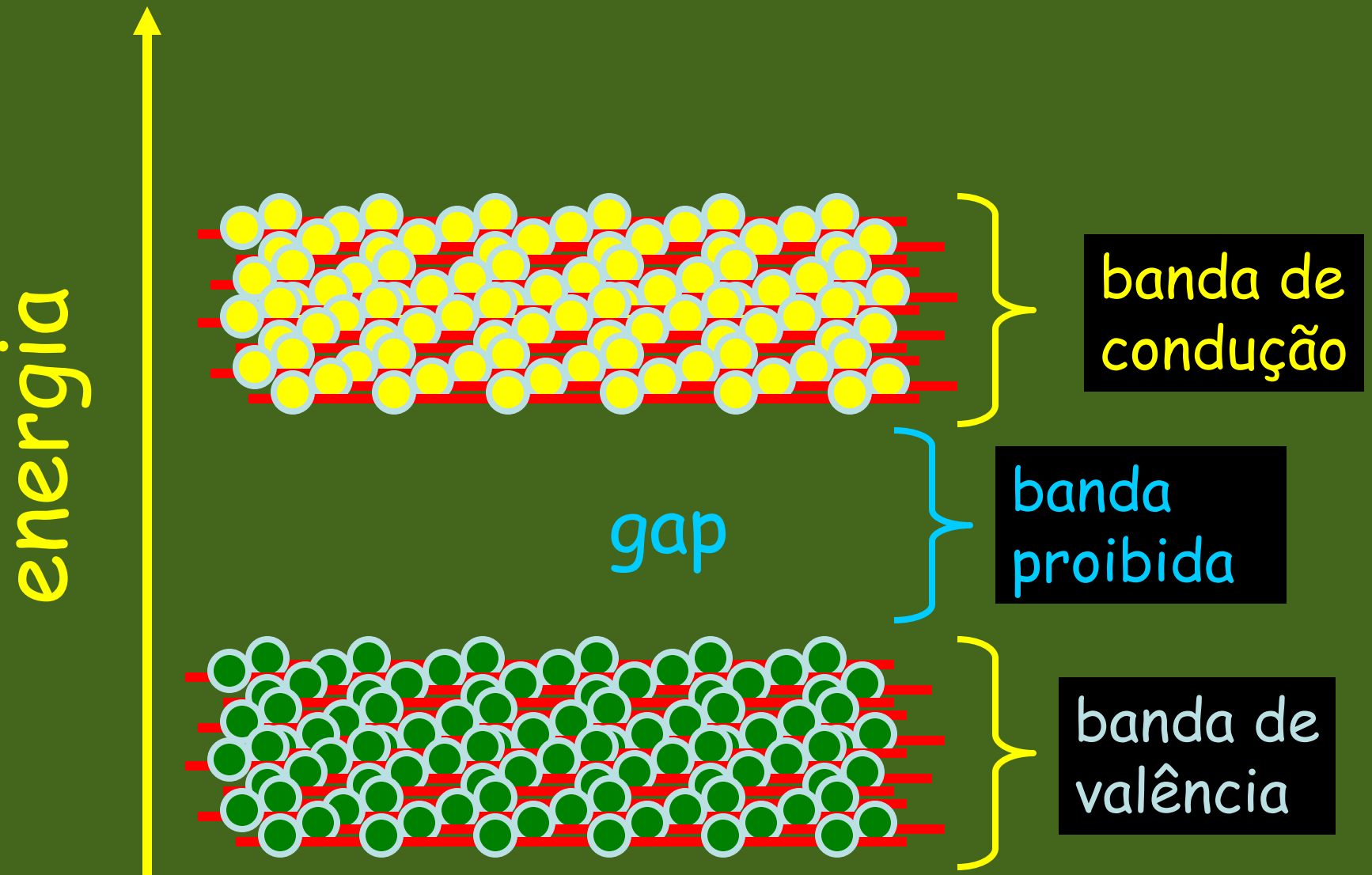


[Ne] $3s^2\ 3p^2$

Silicon


energia


energia

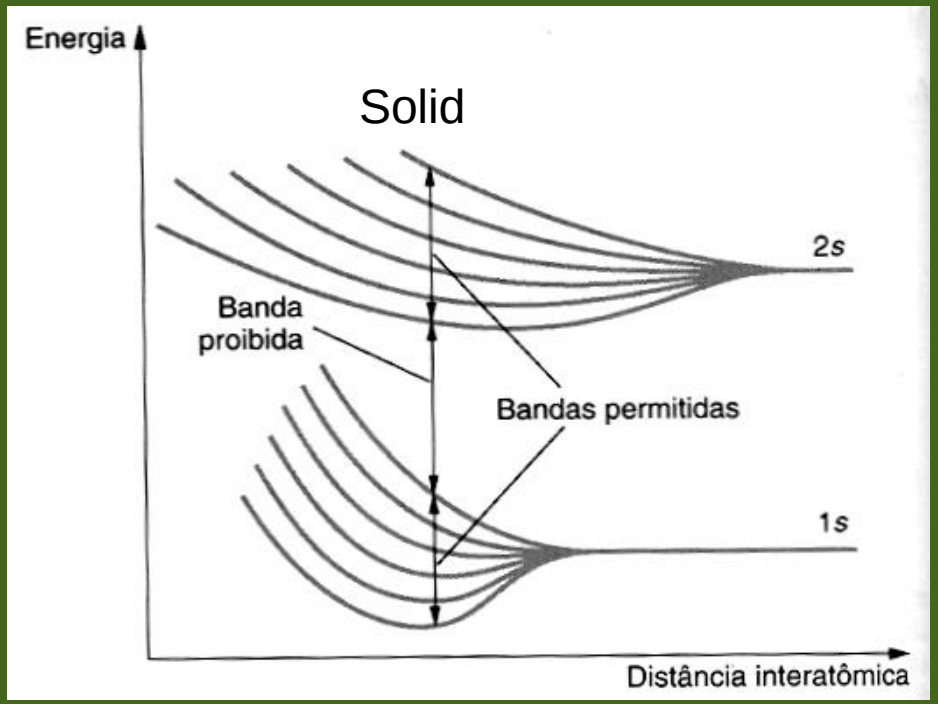

energia
banda de condução
gap
banda proibida
banda de valência

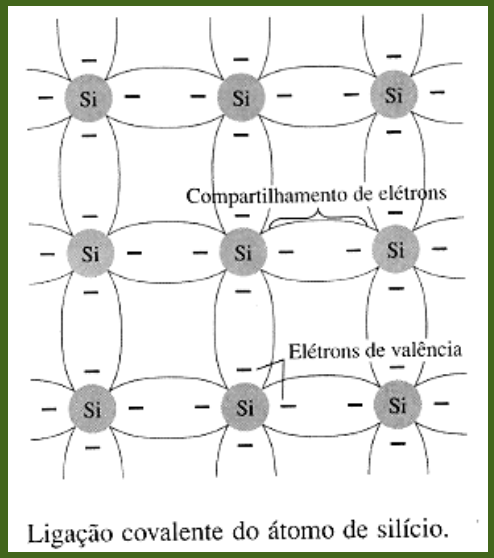
Propriedades elétricas dos materiais

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

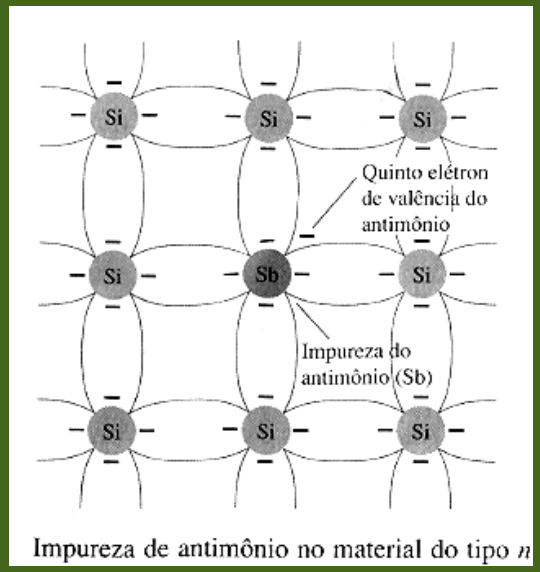
Isolante (ex. vidro): eletrons não podem circular Não conduzem eletricidade.

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 (+))

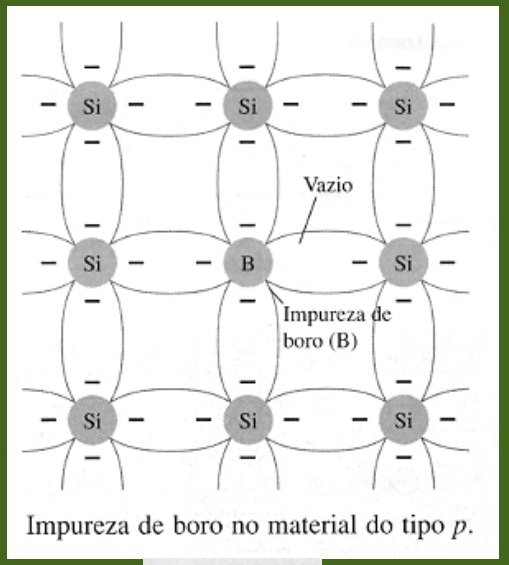




Ligação covalente do átomo de silício.



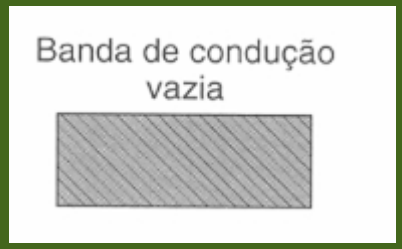
Impureza de antimônio no material do tipo *n*

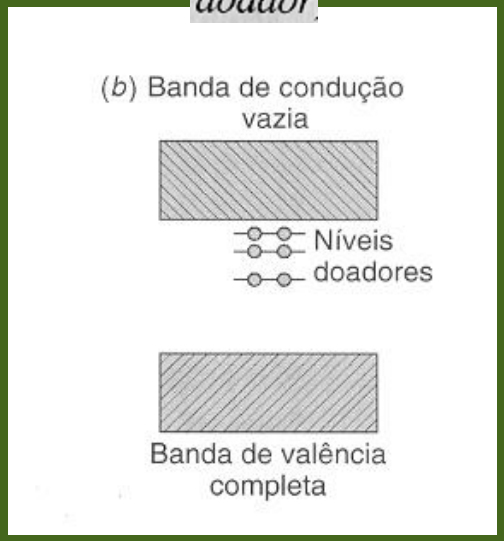


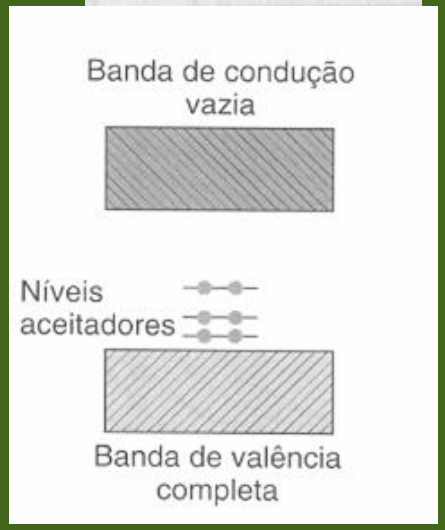
Impureza de boro no material do tipo *p*.

cinco *impurezas* *elétrons de valência* *doador*

impurezas *com três elétrons de* *átomos aceitadores.*







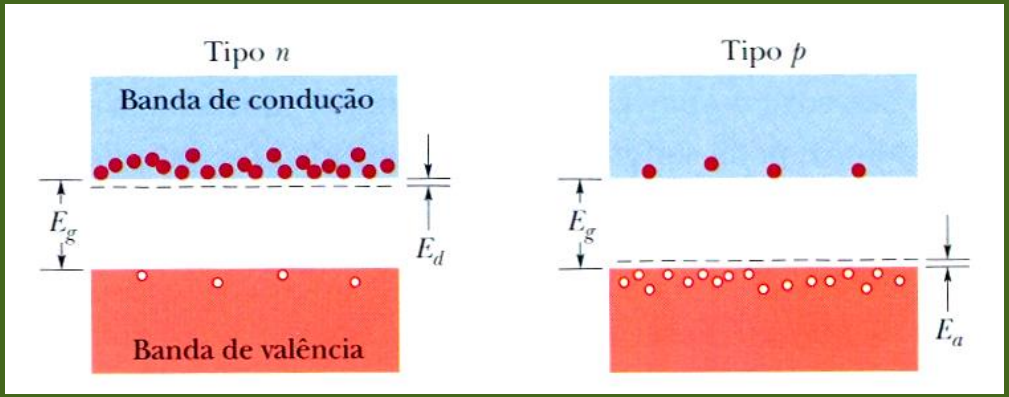
Propriedades elétricas dos materiais

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*)

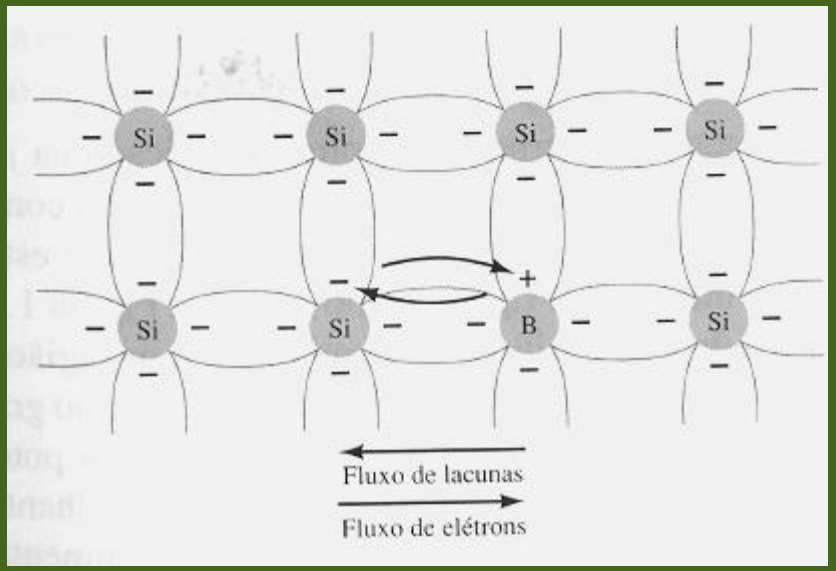
Átomos com mais eletrons (P, Sb):
fica um elétron extra,
impureza doadora, dopagem *n*

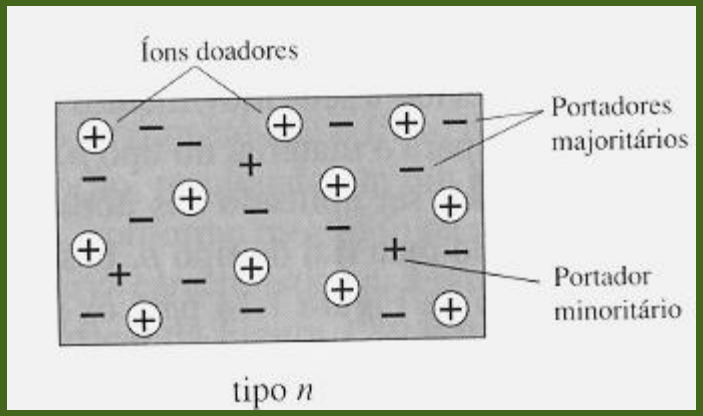
Átomos com menos eletrons (B,Al,Ga):
fica uma lacuna extra,
impureza receptora, dopagem *p*

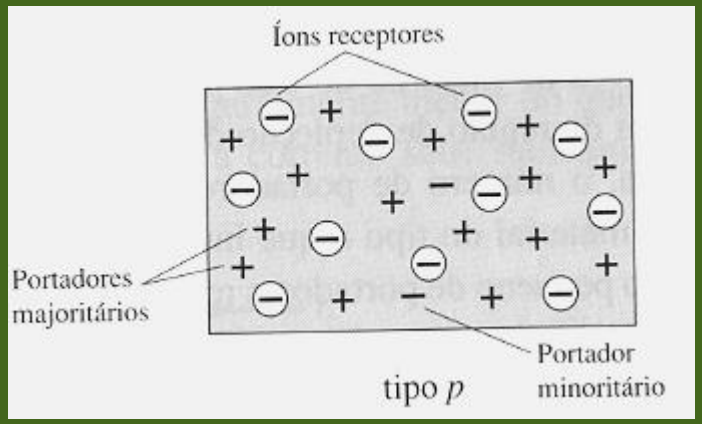


Malvino, *Eletrônica*, 4ta ed., vol. 1, Pearson, Brasil

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

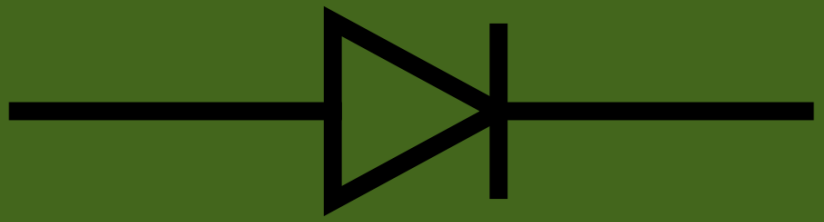

Si
Si
Si
Si
Si
Si
B
Fluxo de lacunas
Fluxo de elétrons


Íons doadores
Portadores majoritários
Portador minoritário
tipo n

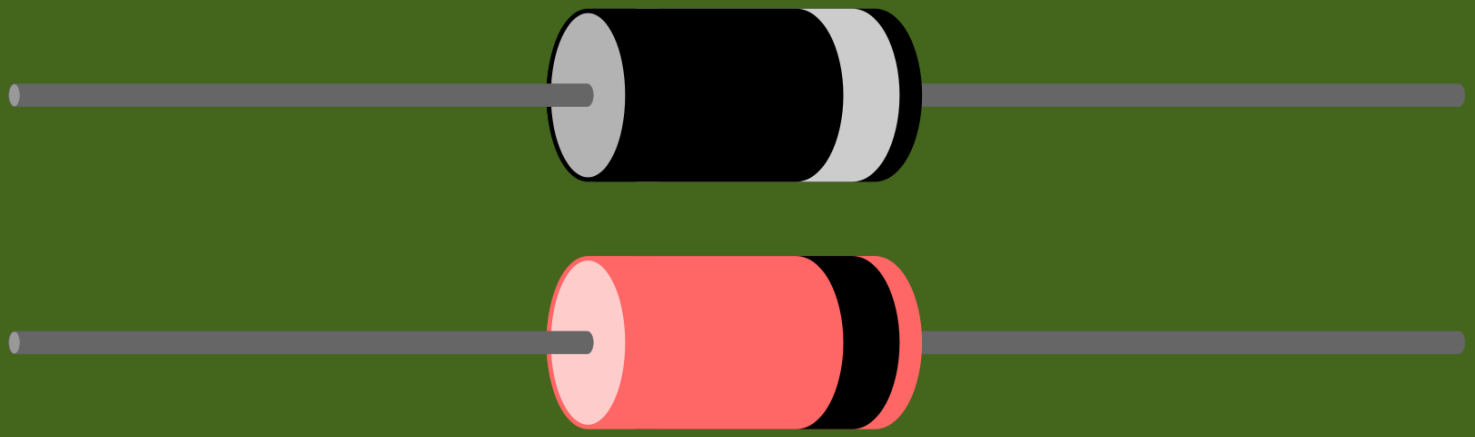

Íons receptores
Portadores majoritários
Portador minoritário
tipo p

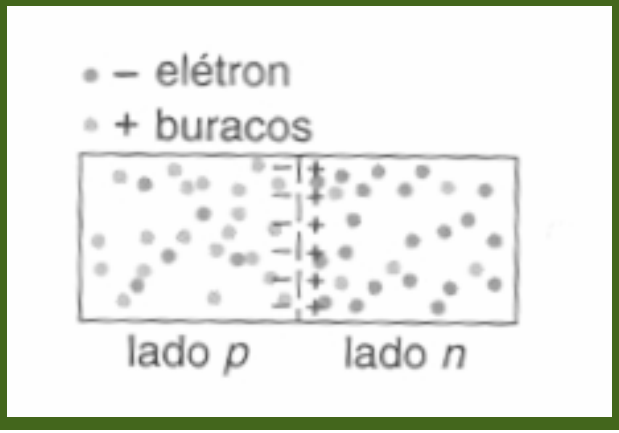
Diode

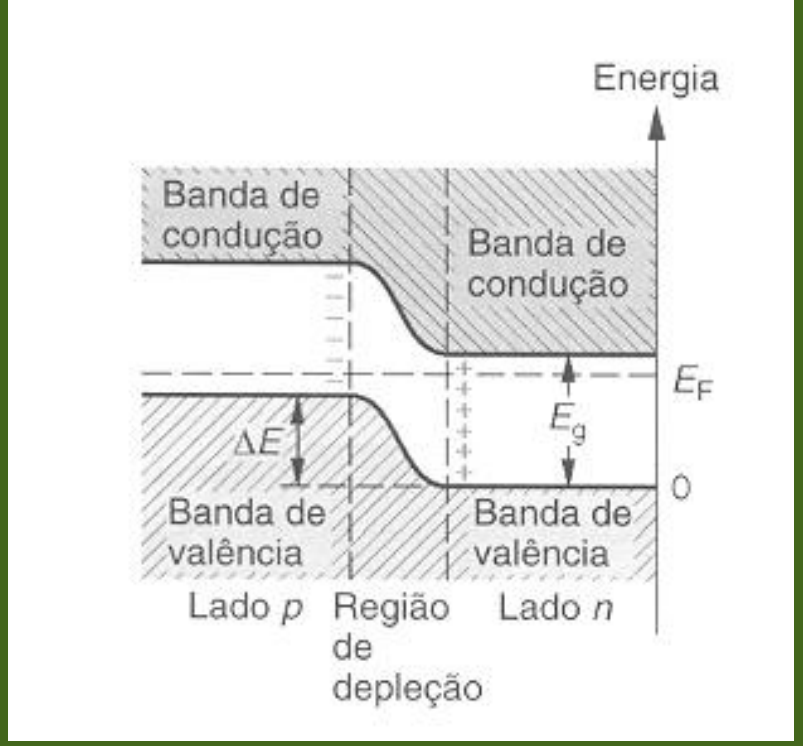
Ânodo
(+)

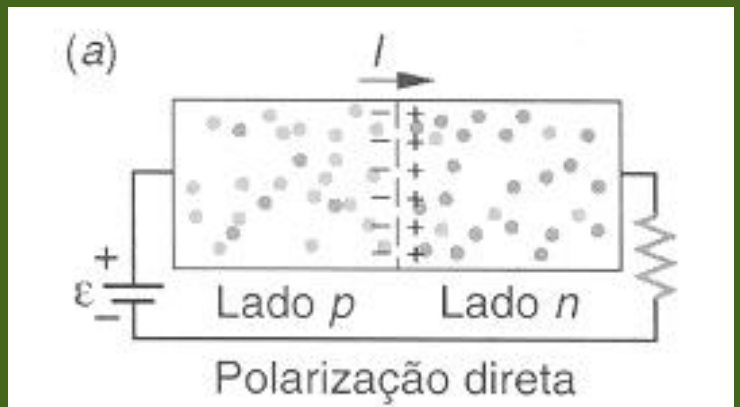


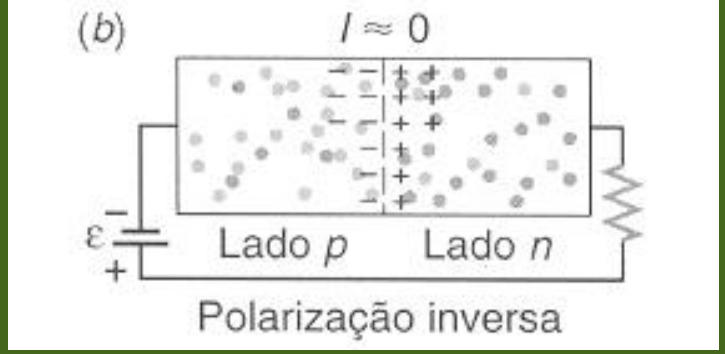
Cátodo
(−)

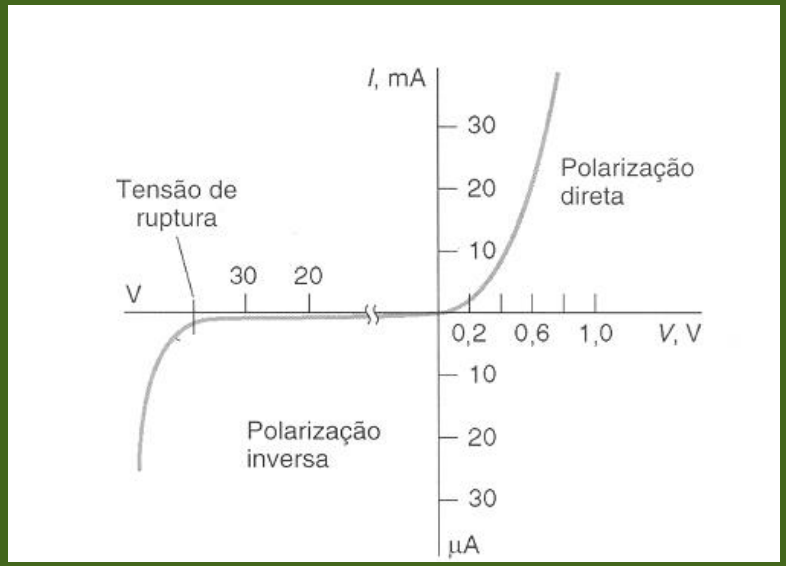


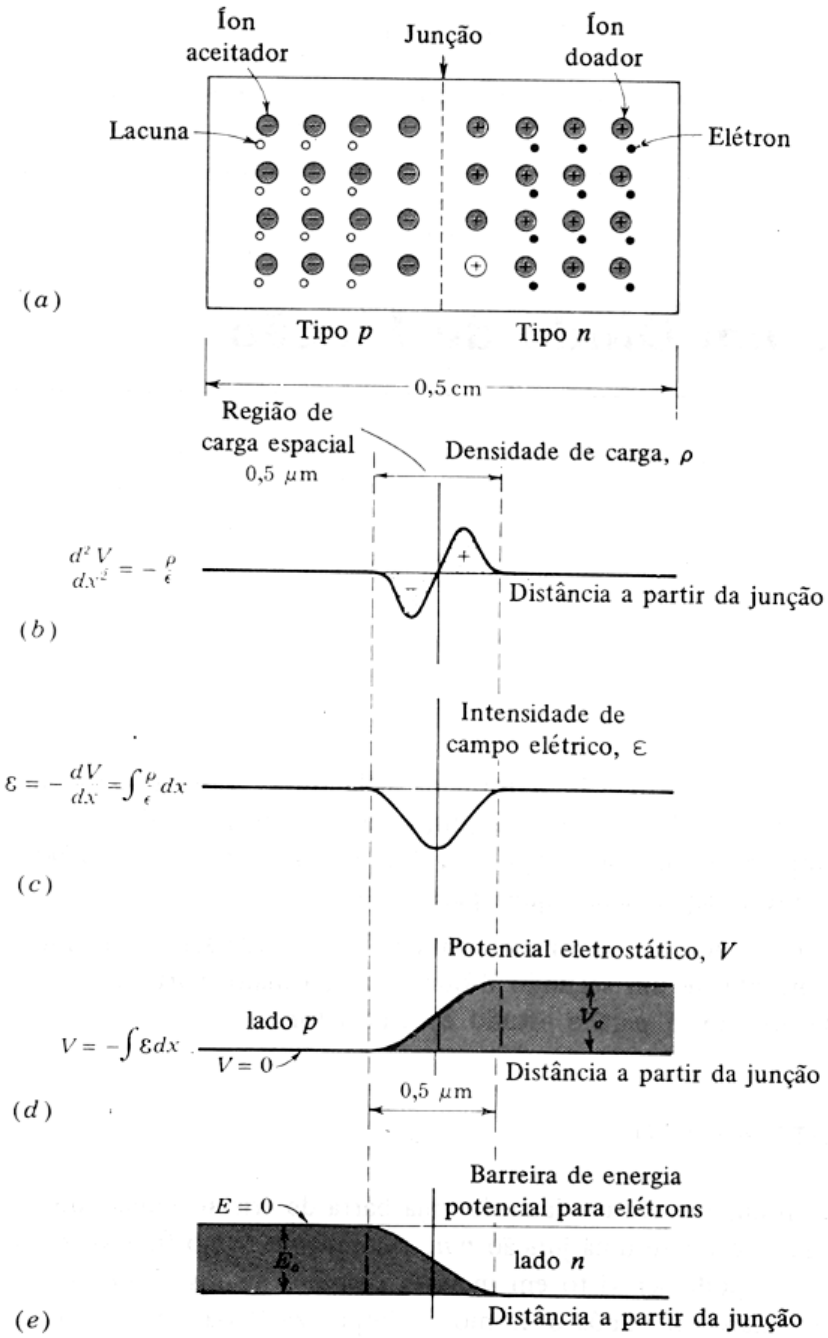

– elétron
+ buracos
lado p
lado n


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

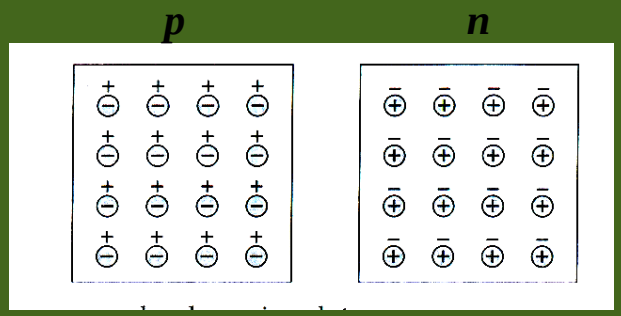

(a)
I
+
ε
–
Lado p
Lado n
Polarização direta

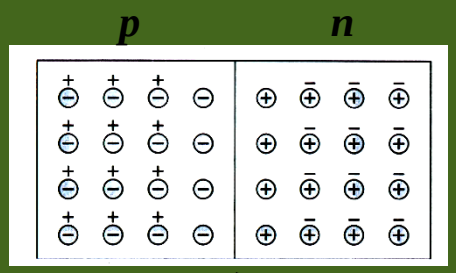

(b)
I ≈ 0
ε
–
+
Lado p
Lado n
Polarização inversa

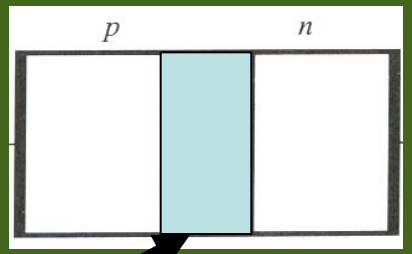

I, mA
30
20
10
Polarização direta
Tensão de ruptura
V
30
20
0,2
0,6
1,0
V, V
10
20
30
μA
Polarização inversa


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
$\mathcal{E} = -\frac{dV}{dx} = \int \frac{\rho}{\epsilon} dx$
(c)
Potencial eletrostático, V
$V = -\int \mathcal{E} dx$
lado p
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)

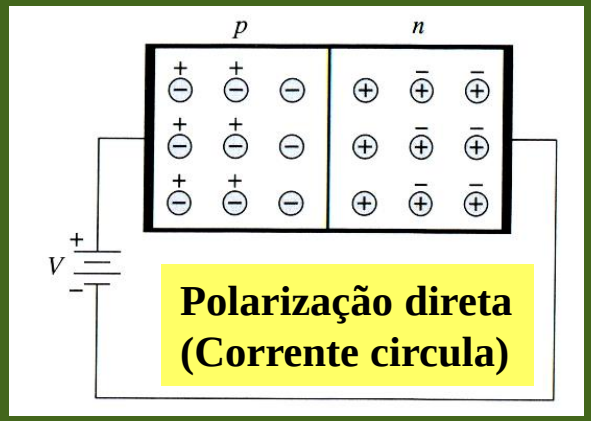
Junção *p-n*



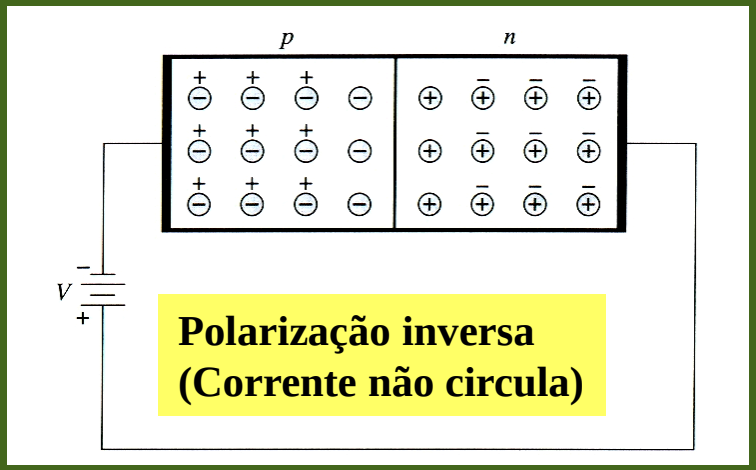




Camada de depleção
(barrera de potencial 0.3 eV Ge, 0.7 eV Si)



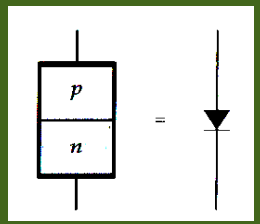
Polarização direta
(Corrente circula)

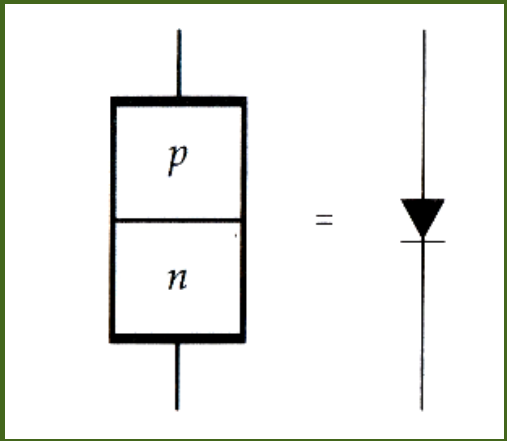


Polarização inversa
(Corrente não circula)

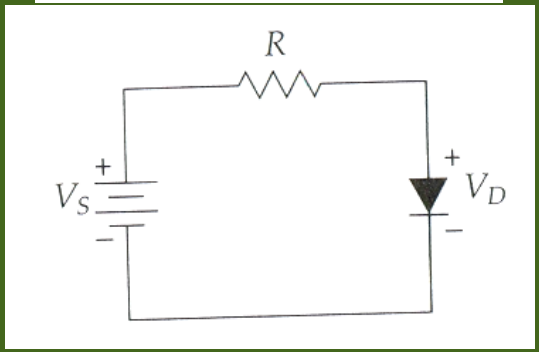
Diodo

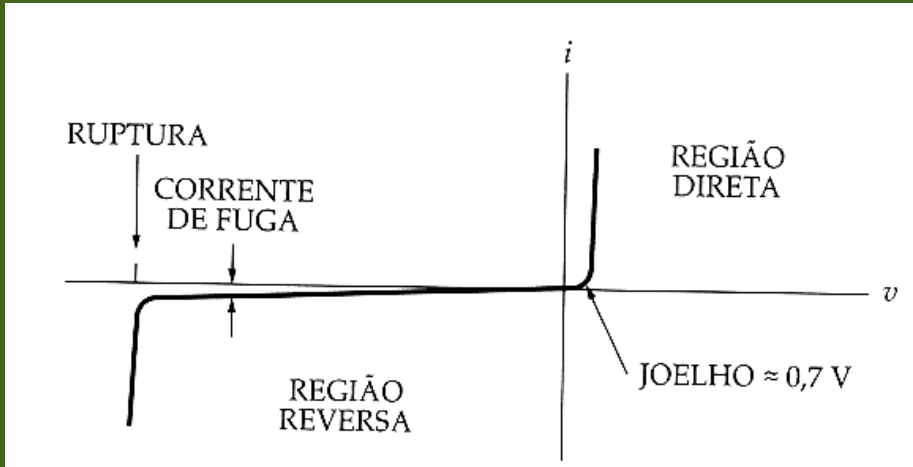
(contração “dois –eletrodos”)





polarização direta.



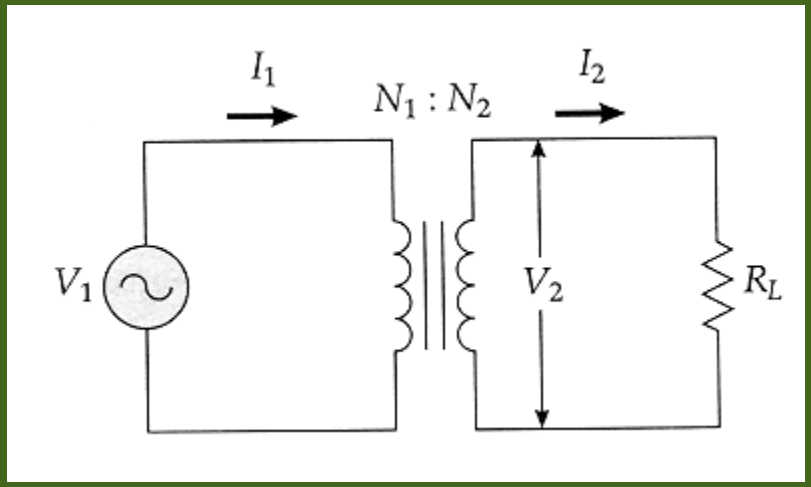


A curva do diodo.

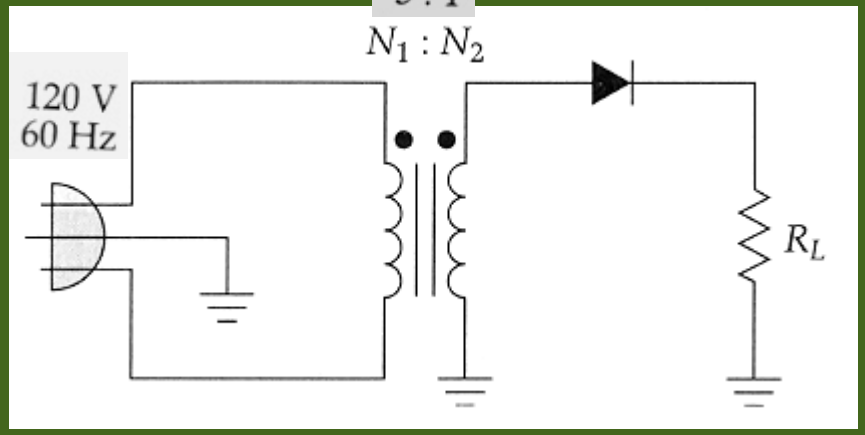
Fontes e retificação

O transformador com carga.

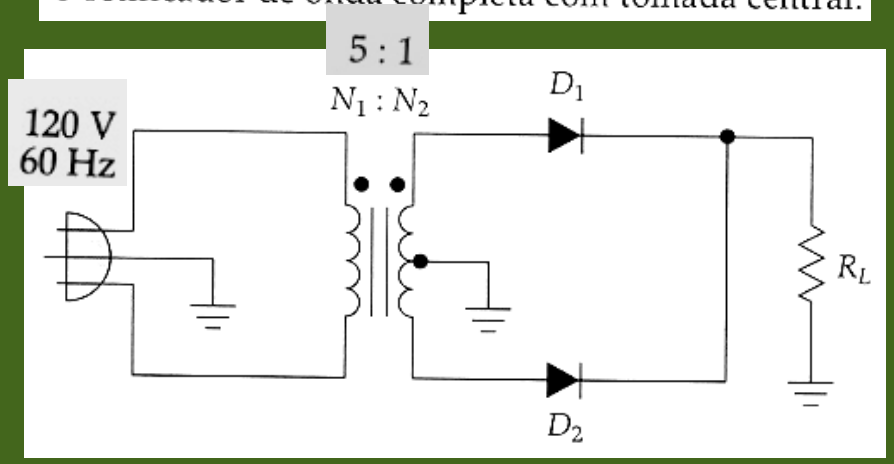
$$V_2 = \frac{N_2}{N_1} V_1$$

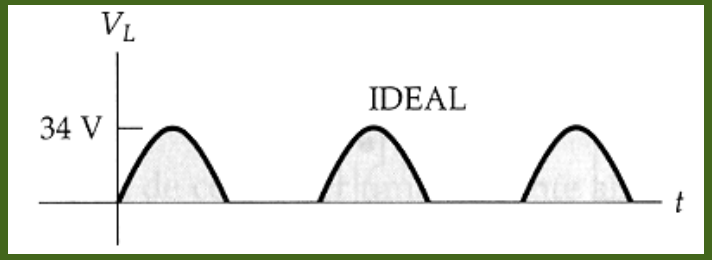


O retificador de meia onda.

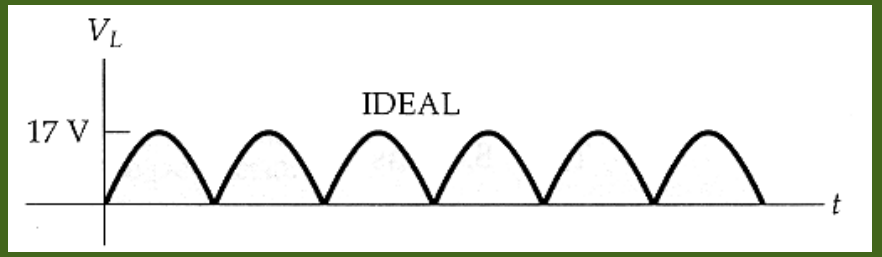


O retificador de onda completa com tomada central.



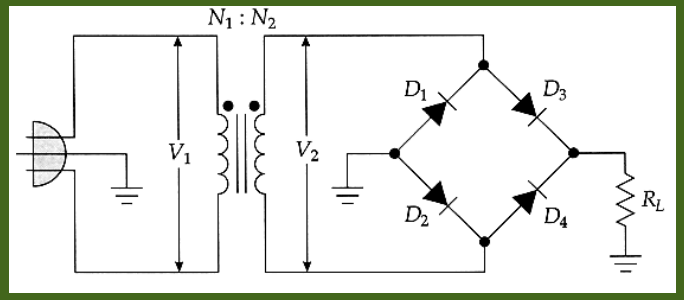


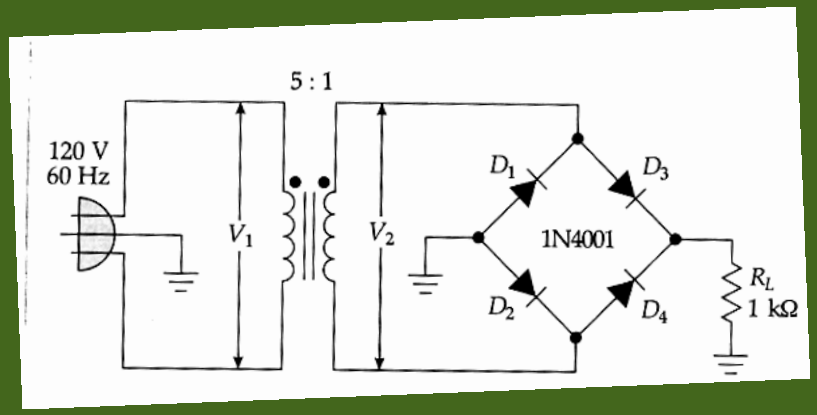
O sinal de meia onda.



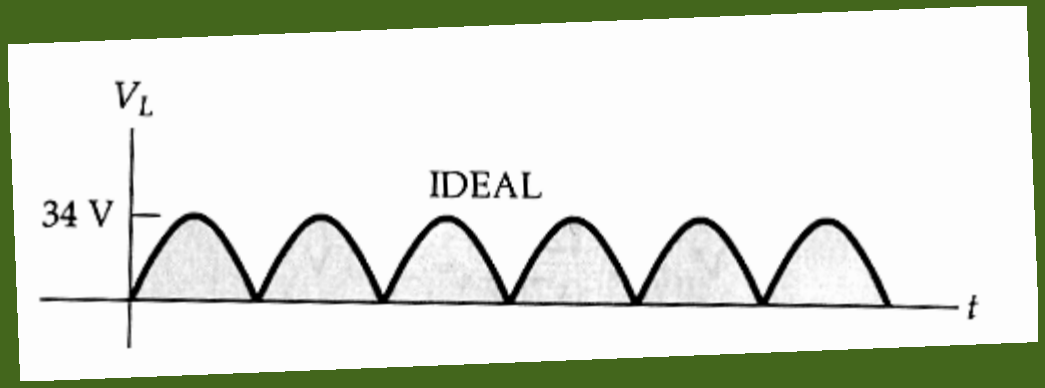
O sinal de onda completa.

O retificador de onda completa em ponte.

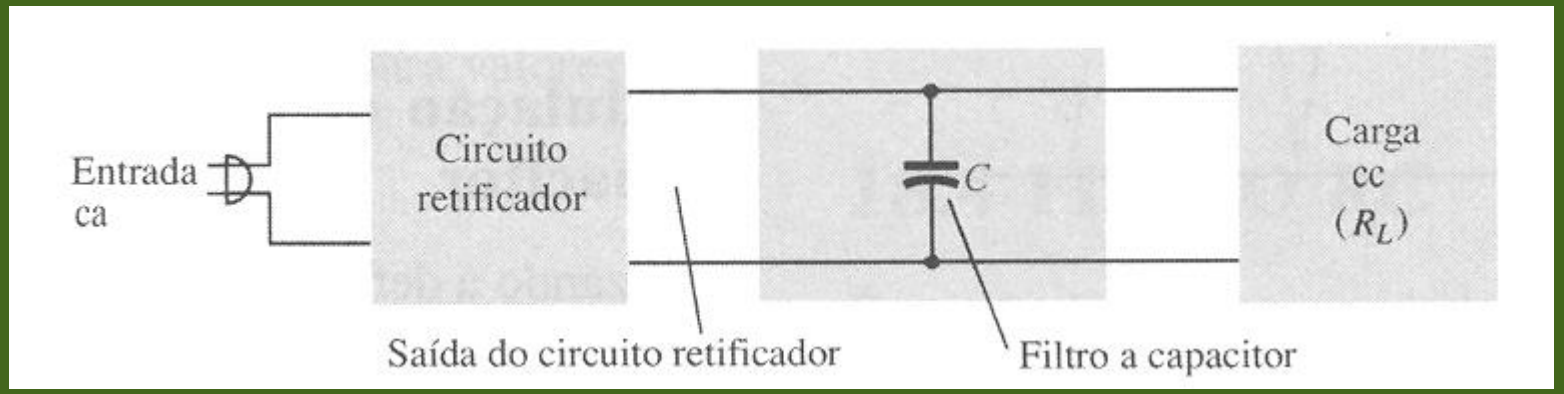


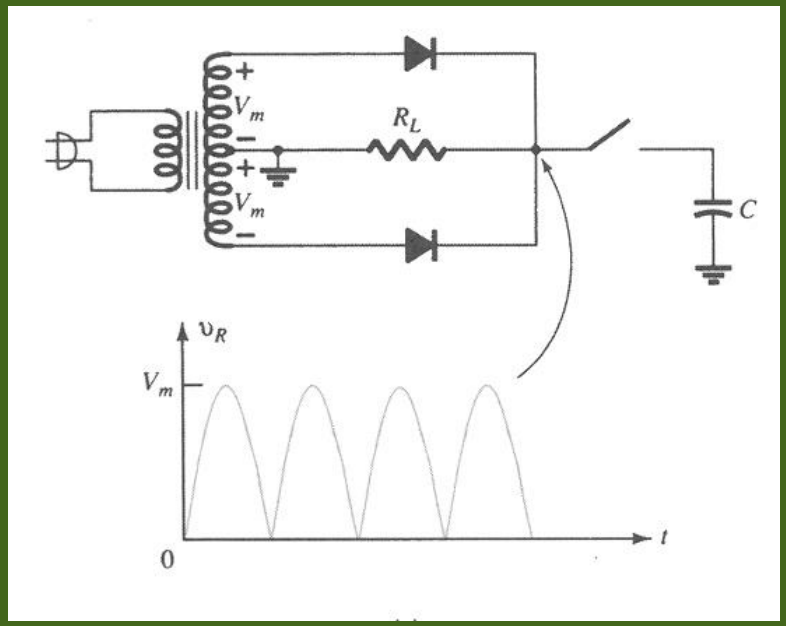


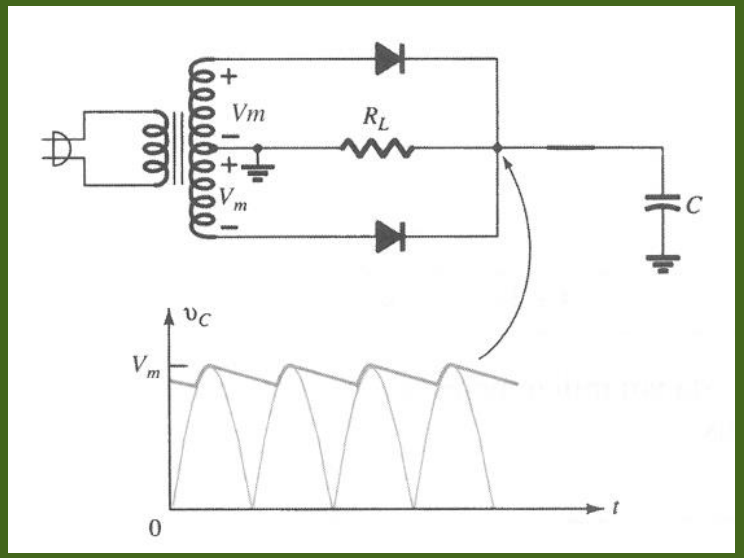
$$V_p = 34\ \text{V} - 2(0{,}7\ \text{V}) = 32{,}6\ \text{V}$$

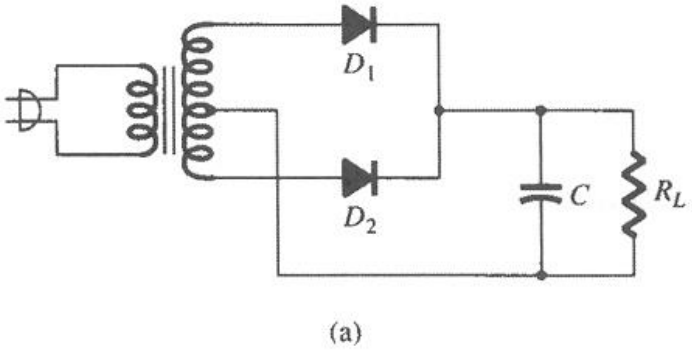


O sinal de onda completa.

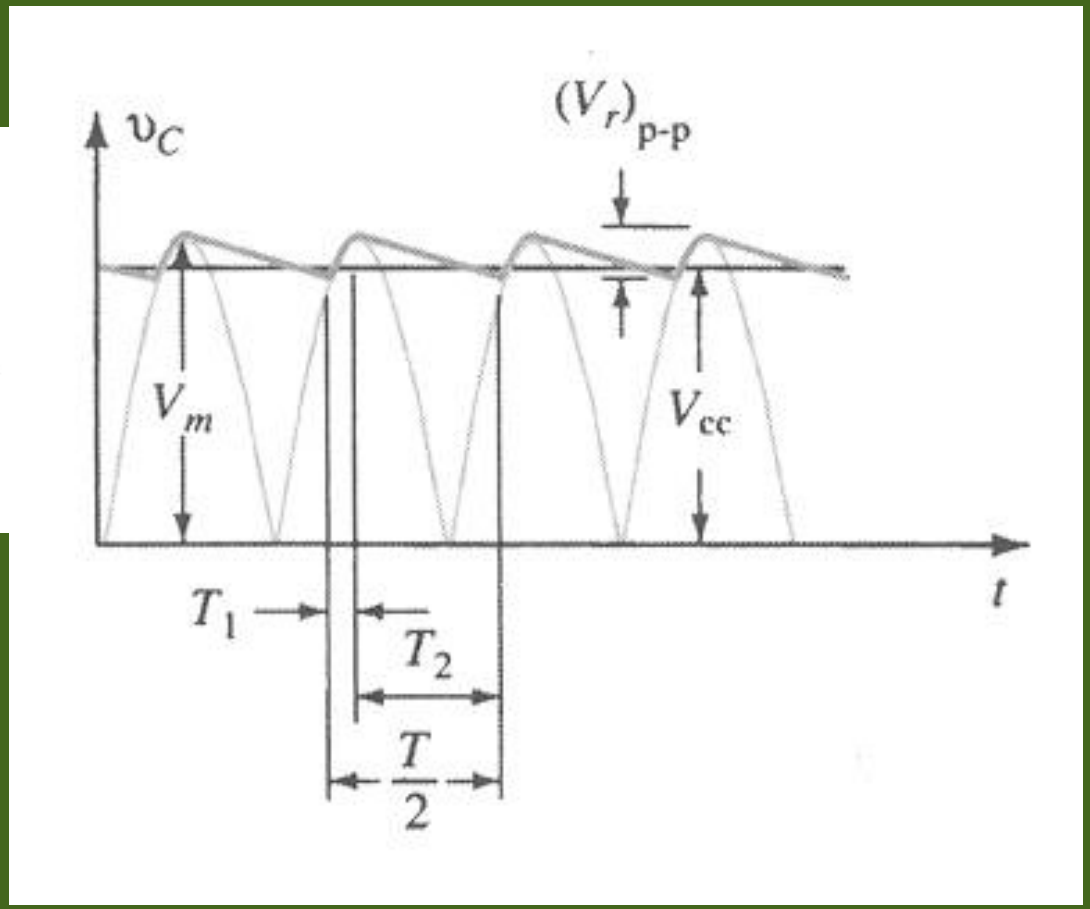

Entrada
ca
Circuito
retificador
C
Carga
cc
(R_L)
Saída do circuito retificador
Filtro a capacitor

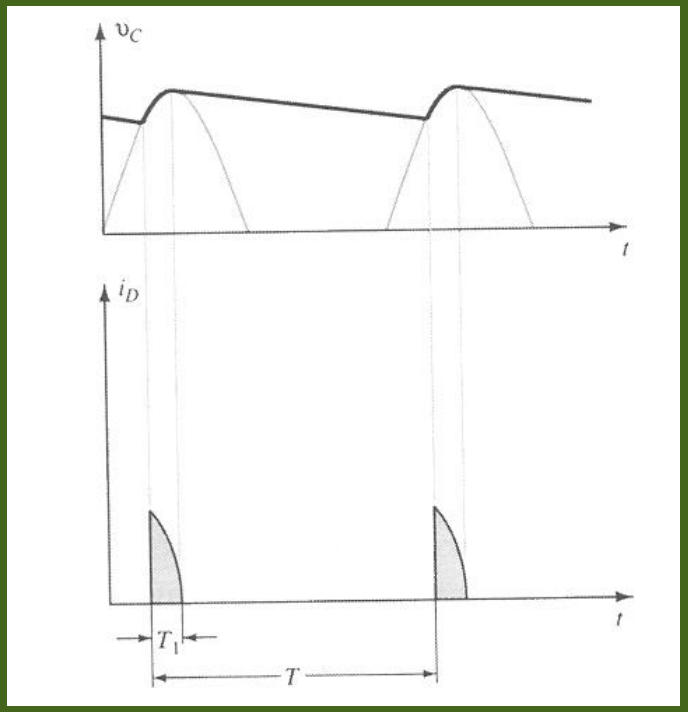

+
V_m
–
R_L
+
V_m
–
C
υ_R
V_m
0
t

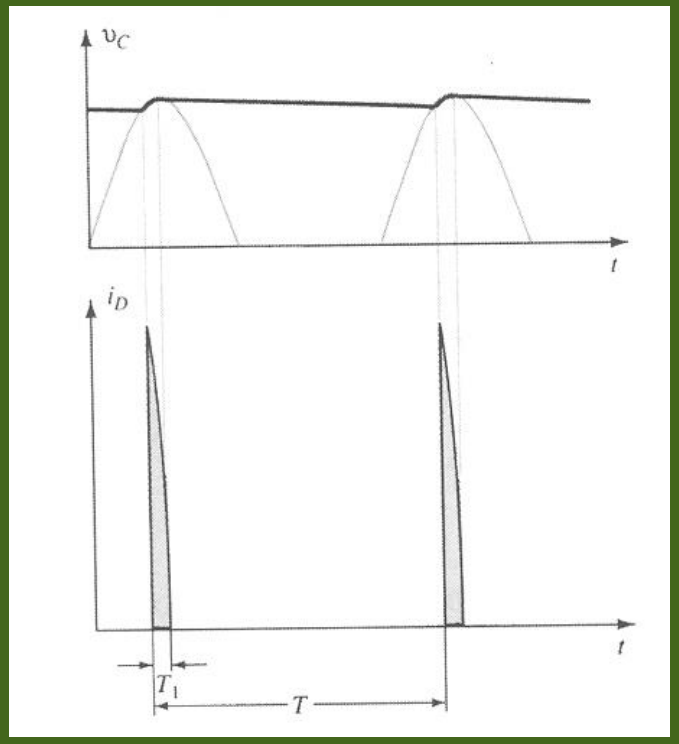

+
Vm
–
R_L
+
V_m
–
C
υ_C
V_m
0
t



(a)

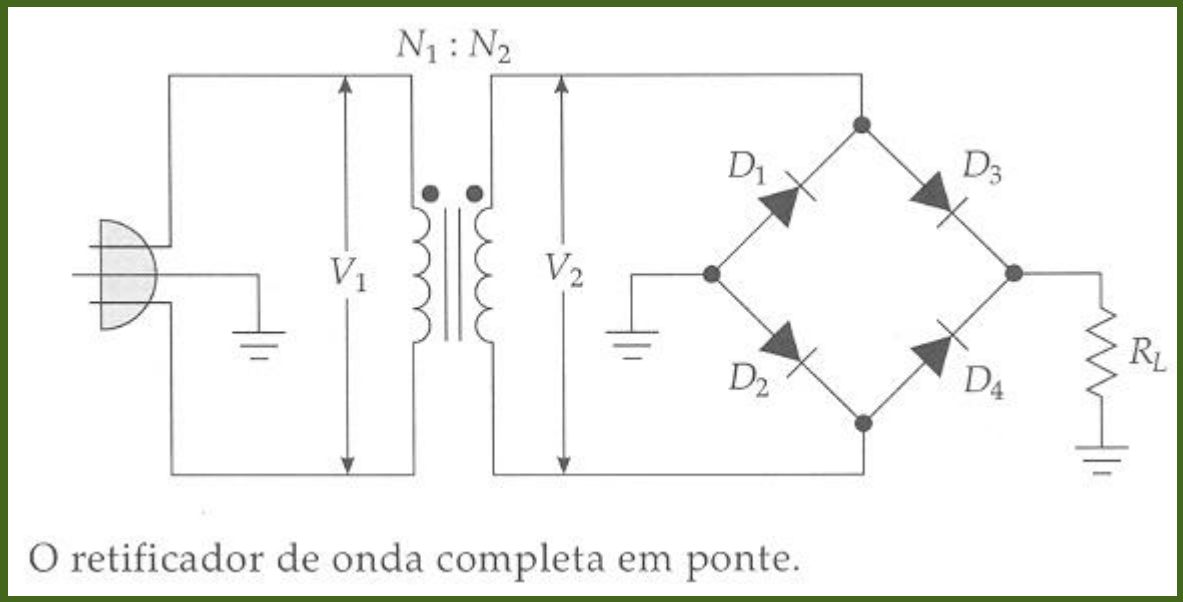




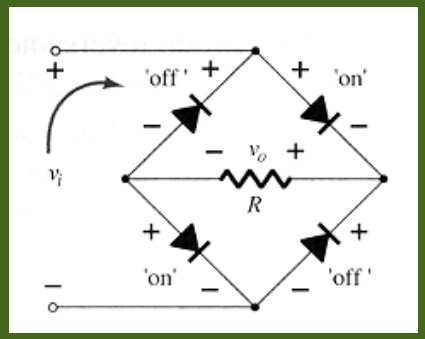


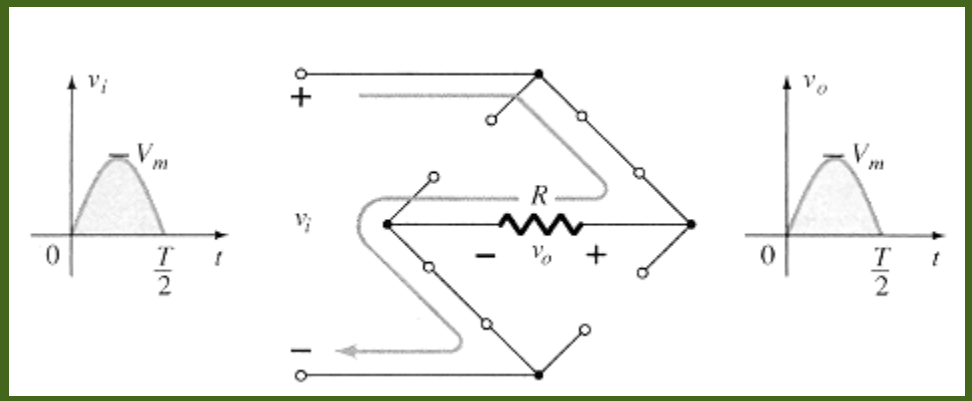
Tensão de saída e formas de onda da corrente no diodo

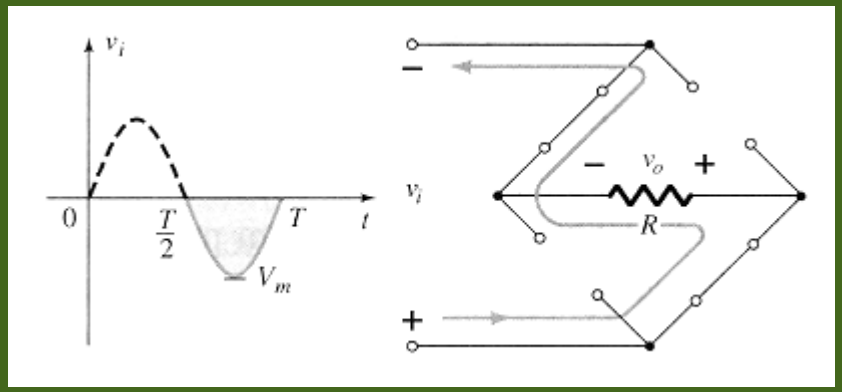
(a) C pequeno; (b) C alto.

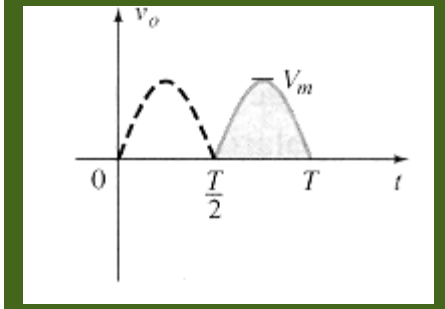


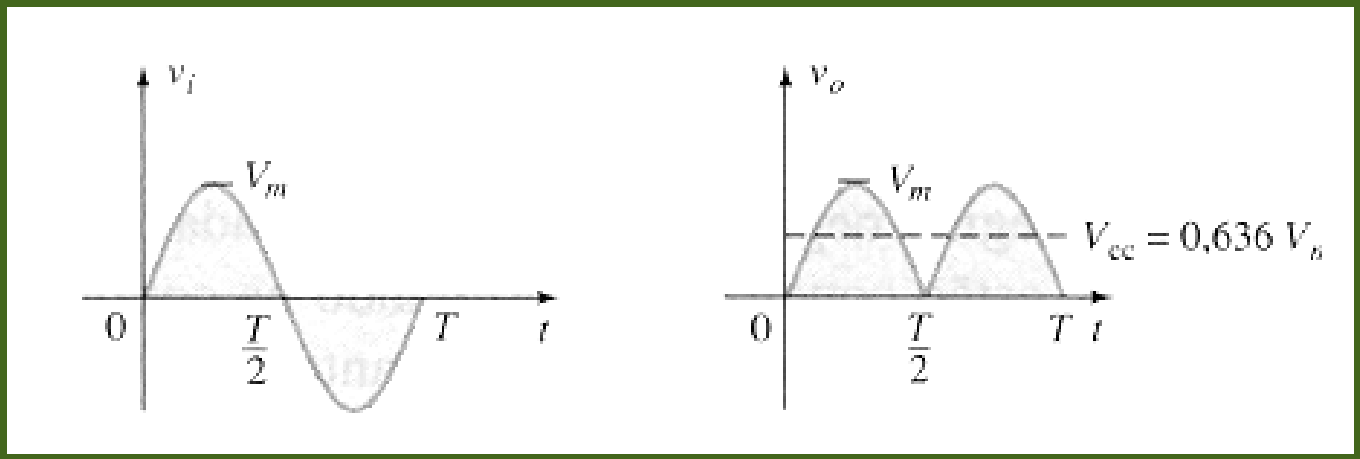
O retificador de onda completa em ponte.

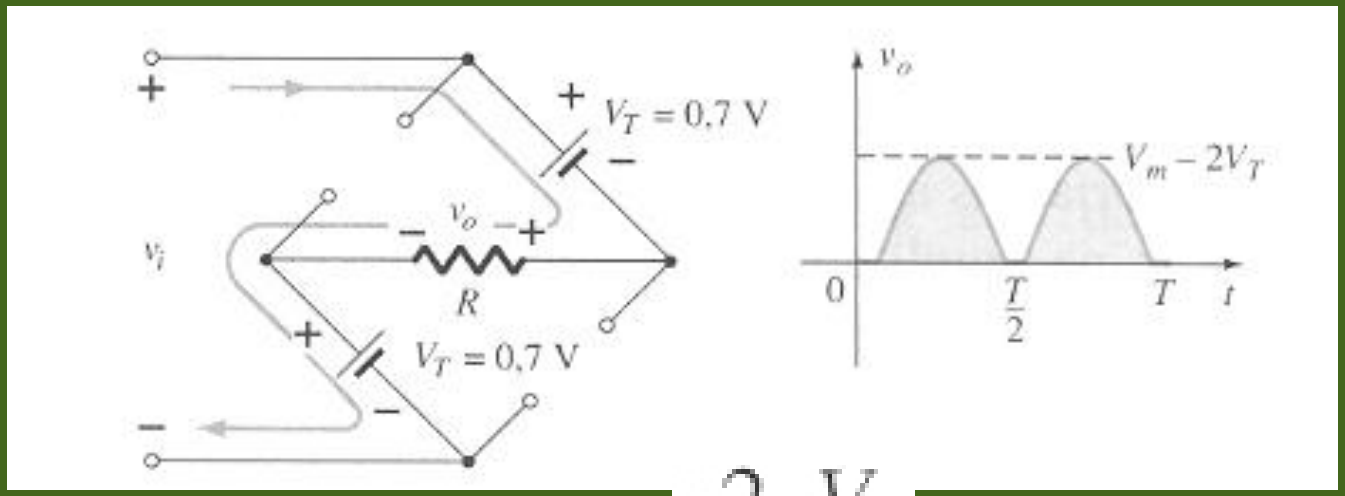

'off'
'on'
v_o
R
v_i
'on'
'off'


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

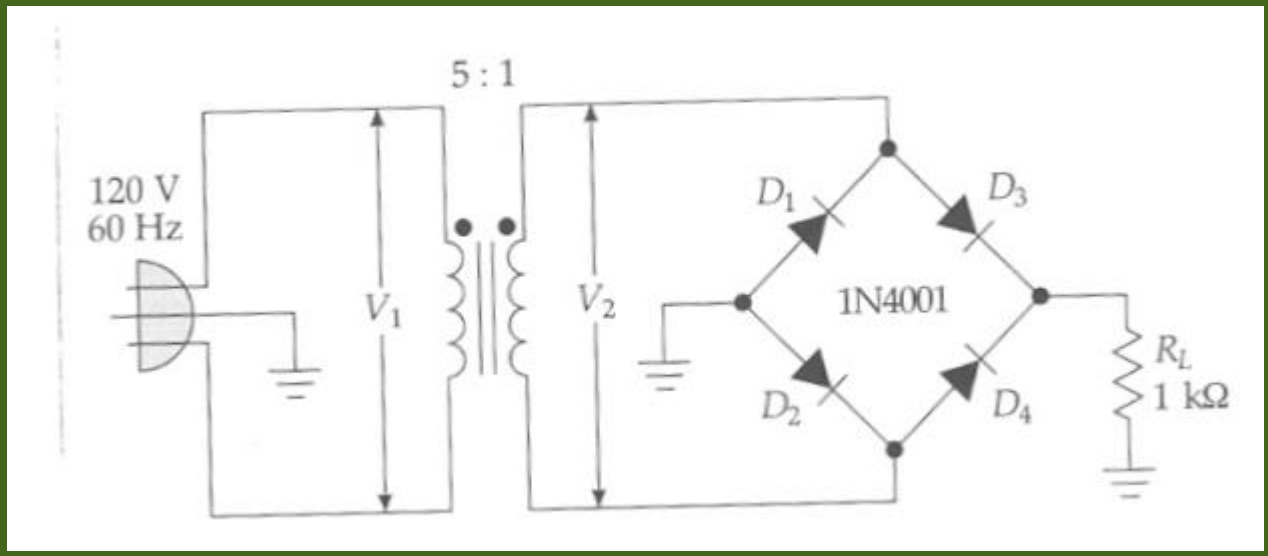

v_i
0
$\frac{T}{2}$
T
t
V_m
v_i
v_o
R


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

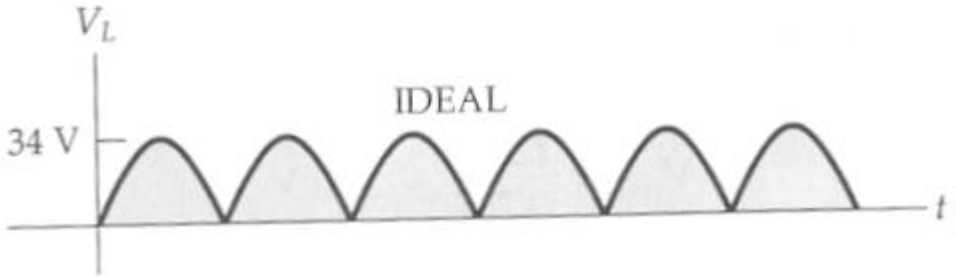

v_i
V_m
0
$\frac{T}{2}$
T
t
v_o
V_m
$V_{cc} = 0{,}636\ V_s$
0
$\frac{T}{2}$
T
t



$2\ V_T$

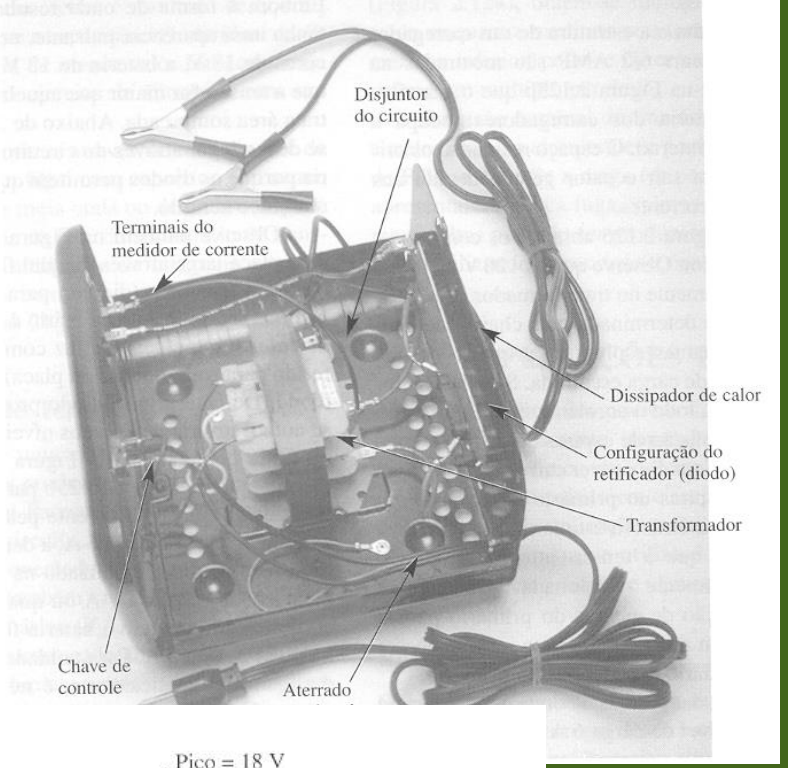


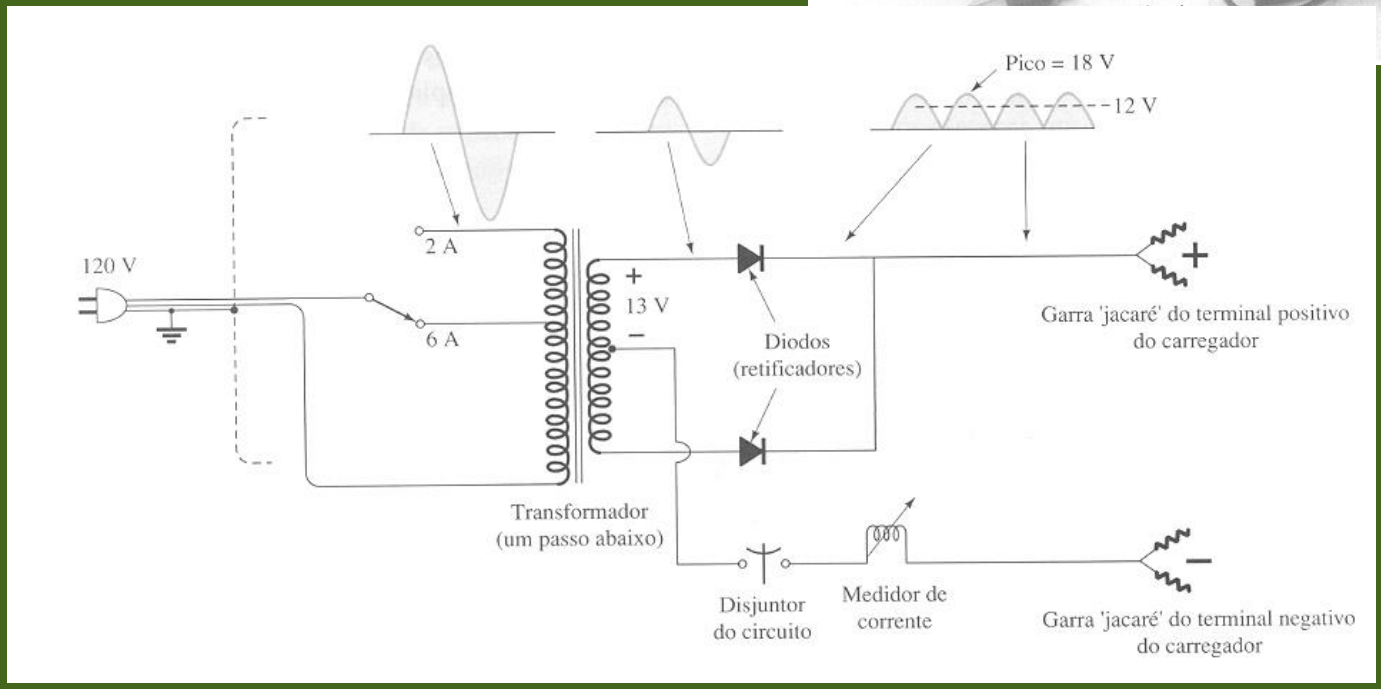
$$V_p = 34\ \text{V} - 2(0{,}7\ \text{V}) = 32{,}6\ \text{V}$$



O sinal de onda completa.

Carregador de bateria





Atendendo a pedido: Econtrei uma versao estudante do circuit Maker, free. Acho que o site é seguro. É um simulador de circuitos. Entrem por conta propria e risco.
O circuitMaker nao é mais vendido. O aplicativo que uso foi comprado ha 20 anos atras!!!

Entre
em: https://docente.ifrn.edu.br/leonardoteixeira/links/instalador-do-circuitmaker-student/view
è um site da Univ. Feder. Do Rio Grande do Norte.
Aparece a tela abaixo. Clique em circuimaker_student.exe
DEpois é só colocar teu nome e o da UNICAMP.
Voce aprenderá a usa-lo assistindo minhas aulas.
Abraços.

End!!!