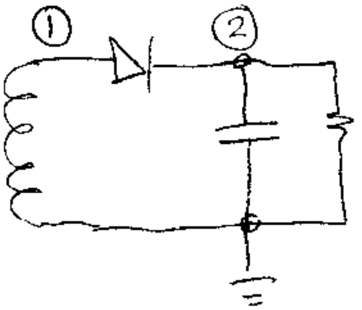
Reverse voltage across diodes – with filter

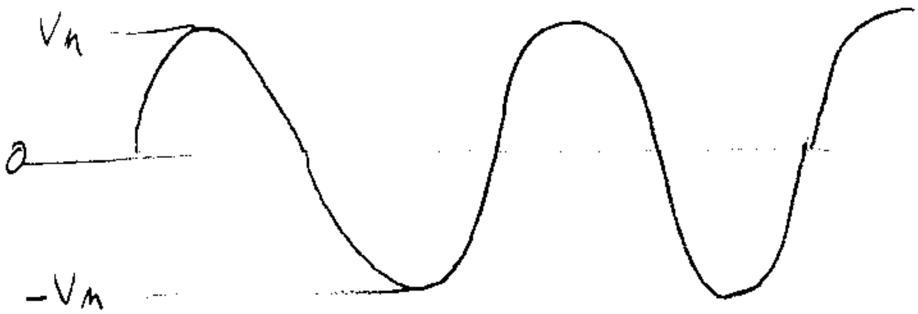
Here's a circuit



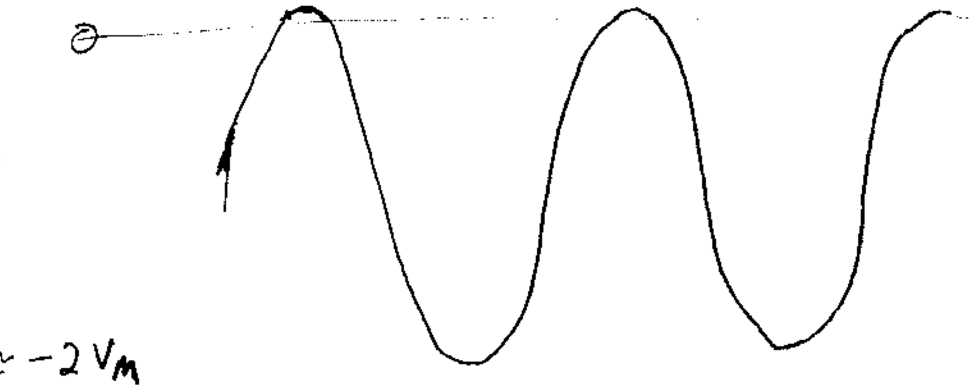
Recall ...

The output voltage is: (node ②)

The voltage at node ① is:



The voltage across the diode is:
(V② – V①)



The peak voltage across the diode is twice the max delivered voltage. →

$\approx -2V_M$

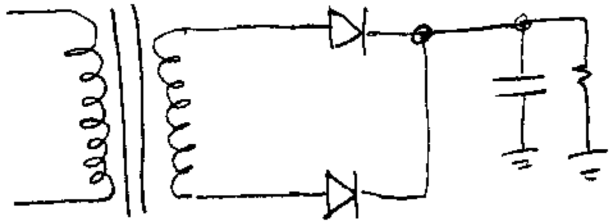
Twice what it was with no capacitor.

What about full wave? ________

bridge? ________

Designing a power supply

① Pick a topology



② Determine V_M, V_L from specs.

③ Take V_M. Add voltage lost in diodes.

④ Add transformer loss. (like a resistance)

→ This is peak secondary voltage

⑤ Convert to RMS if needed. (depends on specs)

⑥ Calculate turns ratio

$$\frac{V_{sec}}{V_{pri}} \quad \text{or} \quad \frac{V_{pri}}{V_{sec}}$$

Express as n : 1 (step down)
or 1 : n (stepup)

⑦ Determine capacitor value

⑧ Determine voltage, power, current ratings of components.

Example

You are designing a power supply for the high voltage on a cathode ray tube.

Your power source is 7 volts AC (10 volts peak)
20 KHz

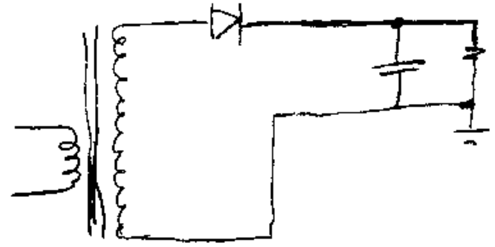
The supply must deliver 20-25 KV.
(25 KV max, 20KV min, 5 KV max ripple)
with a load current of 1ma.

Assume a 10 volt drop in the diode.
(It is really 16 diodes in series.)

Choose a topology.

Then find:
- Turns ratio (pri : sec)
- Capacitor
- Voltage rating of diode
- Peak diode current
- Average primary current
- Power delivered to load

Topology: half wave.



Ignore 10 volt diode loss.

$V_M = 25$ KV

$V_L = 20$ KV

$V_r = 5$ KV.

Ignore transformer resistance.

Power delivered to load:

$(25\text{KV})(1\text{ma})$

$= 25$ watts

Average primary current

$(1\text{ma})(2500) = 2.5$ A.

Peak diode current:

$$Q = CV = (10^{-11})(5\times10^{3})$$

$$= 50\times10^{-9}$$

$$= I T_p = (10^{-3})(50\times10^{-6})$$

$$= 50\times10^{-9}$$

$$\Delta t = \frac{\sqrt{\frac{2V_r}{V_M}}}{\omega} = \frac{\sqrt{\frac{(2)(5)}{25}}}{2\pi(20\text{K})}$$

$$= \frac{\sqrt{\frac{10}{25}}}{126\times10^{3}} = \frac{.632}{126\times10^{3}}$$

$$\approx 5\times10^{-6} = 5\,\mu\text{S}$$

$$i_{cap} = \frac{Q}{\Delta t} = \frac{50\times10^{-9}}{5\times10^{-6}} =$$

$= 10$ ma (avg when on)

$i_{cap_{peak}} \approx 20$ ma.

Turns ratio $= \frac{25000}{10} = 2500$

1:2500

Capacitor:

$$C = \frac{I}{V_r f}$$

$$= \frac{1\times10^{-3}}{(5\times10^{3})(2\times10^{4})}$$

$$= 10\times10^{-12}$$

$= 10$ pf

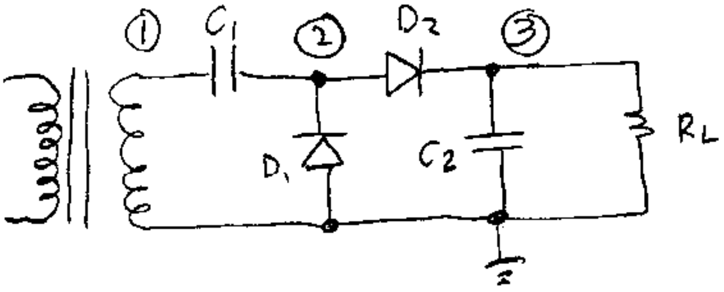
Voltage rating of diode:

50 KV.

(10 5KV diodes)

Voltage multiplying circuits (2.1.4)

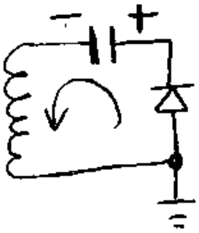
Voltage doubler:



Negative half cycle:

D1 is on. D_2 is off.

C_1 charges to the peak voltage.

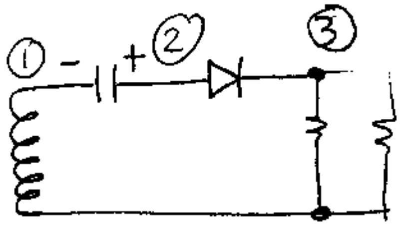


Positive half cycle

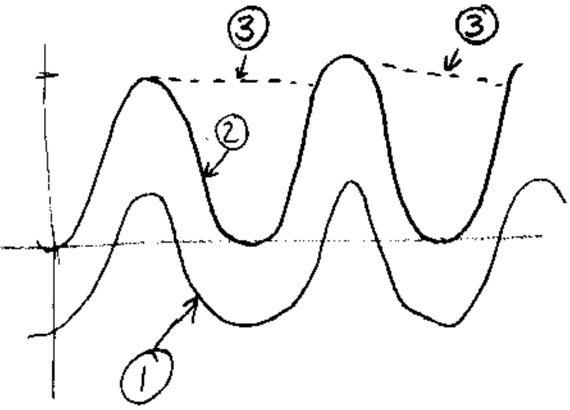
D1 is off D_2 is on

Since C_1 is charged and it is AC coupled,

The peak voltage is twice the input peak.

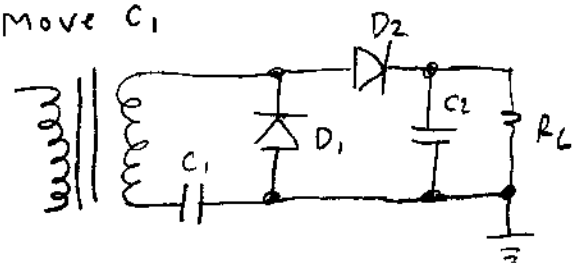


Waveforms

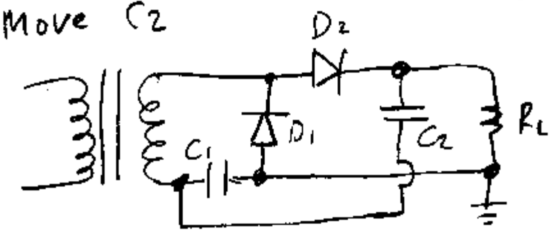


The book's circuit.

Move C_1

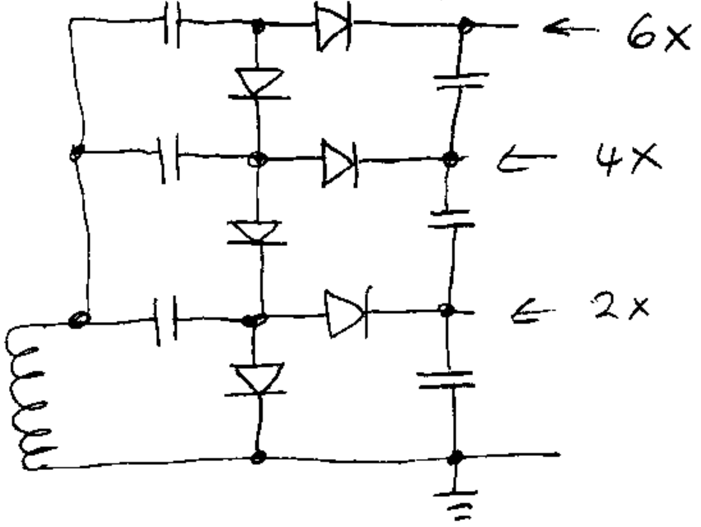


Move C_2



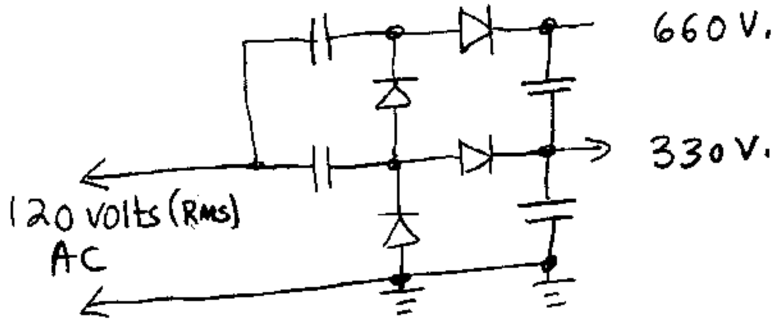
Higher voltages

It is AC coupled, so you can repeat.

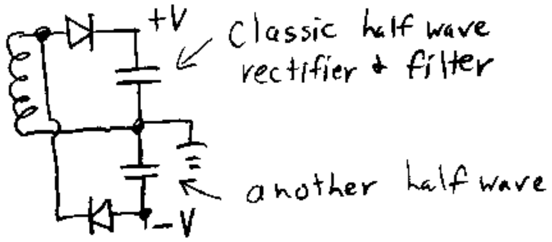


Used when you need a high voltage at low current.

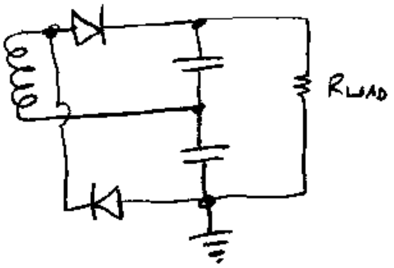
You don't even need a transformer!



The book's circuit – another view



Move the ground
So it is all positive



Advantages: Half the Voltage across C_2

Disadvantage! The transformer floats.