Make a Joule Thief

by 1up on February 14, 2008

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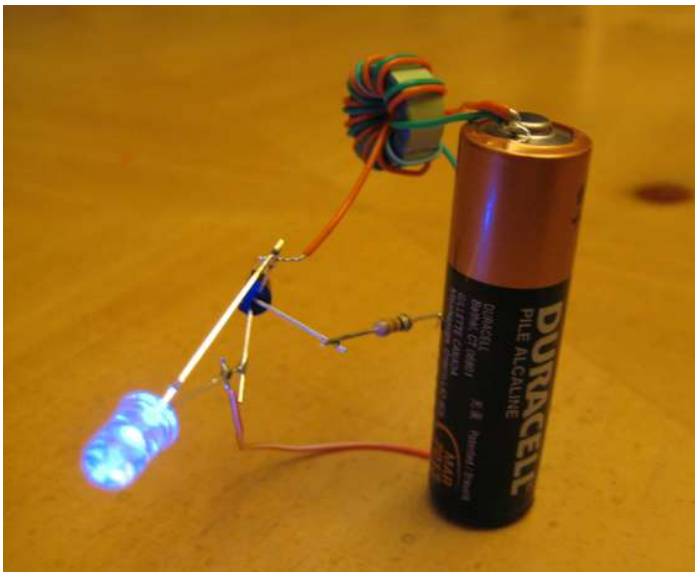
Sometimes my Instructables are few and far between, but I try to make them as well as I can. Hopefully you can be inspired or helped by the content in them!

Intro: Make a Joule Thief

Yes, it's the infamous Joule Thief, in Instructable form! For those of you who don't know, the Joule Thief is a tiny little circuit that allows you to drive a white or blue LED from voltages as low as 0.5 volts. You think those batteries are dead? Don't throw them out yet! Hook them up to the Joule Thief to squeeze every last drop of energy out of them!

The idea and circuit came from this Make weekend project. Why don't you pay them a visit?



Step 1: Parts and Tools

For this project you will need very few tools and parts, as you will see in the picture below.
But for those of you who like it in text, here it is:

Helping Hands (Optional)
Soldering Iron
Solder
A Blue or White LED (Other colors are fine, too)
2N3904 Transistor or equivalent
1k Resistor (Brown-Black-Red)
Toroid Bead
Thin wire, two colors (magnet wire works)

You can get the toroid and transistor from a dead CFL; the transistor is usually labeled 13002.

Also, if you use a 2N4401 or BC337 transistor, your LED will be brighter because they can handle more amps.

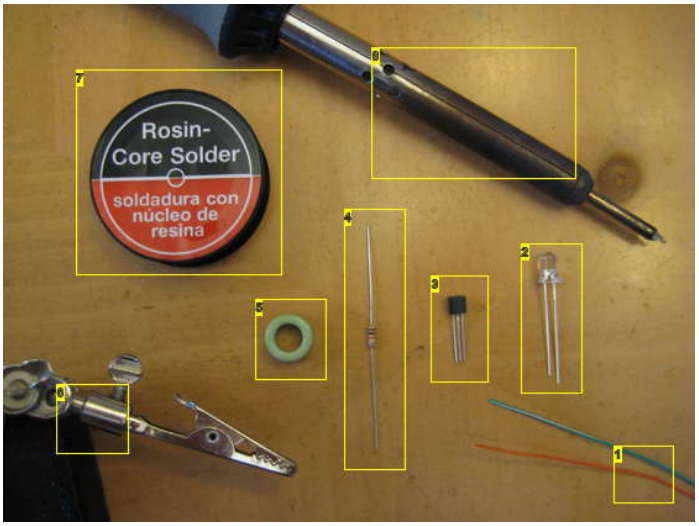


Image Notes

1. Thin wire, at least two colors
2. Blue LED
3. 2N3904 NPN Transistor
4. 1k Resistor (Color code Brown-Black-Red)
5. Toroid Bead
6. Helping Hands (Optional, but really useful in any project)
7. Rosin-Core Solder
8. Soldering Iron

Step 2: Wind the Toroid

The first step is to wind the toroid. I found mine in an old computer power supply, and it works fine for me. Toroids are donut-shaped objects like in the picture, and can be attracted by a magnet.

You can find toroids in a few places. Old computer motherboards, XBOX and X360 motherboards have them (don't take them unless it's dead!). You can find toroids in computer power supplies, or you could buy them at your nearest RadioShack.

Take your two strands of wire, and twist the ends together. You don't have to do this, but it makes winding a little easier.

Thread the twisted end through the toroid, then take the other two ends (Not twisted together) and wind it once around the toroid. Don't twist the wires; make sure that two wires of the same color are not right next to each other.

Keep winding, making sure you wind the coils tight. It will still work if they are kind of loose, but it is better to have them tight.

Ideally, you want about 8-11 turns on your toroid. Even if you can fit more, don't put more on. Make sure the turns are spaced evenly around the toroid.

Once you wind around the whole toroid, cut off the extra wire, making sure you leave a couple of inches for soldering.

Strip some insulation off the wires, then take a wire from each side, making sure they are of the OPPOSITE COLOR. Twist them together, and then you're done with the toroid.

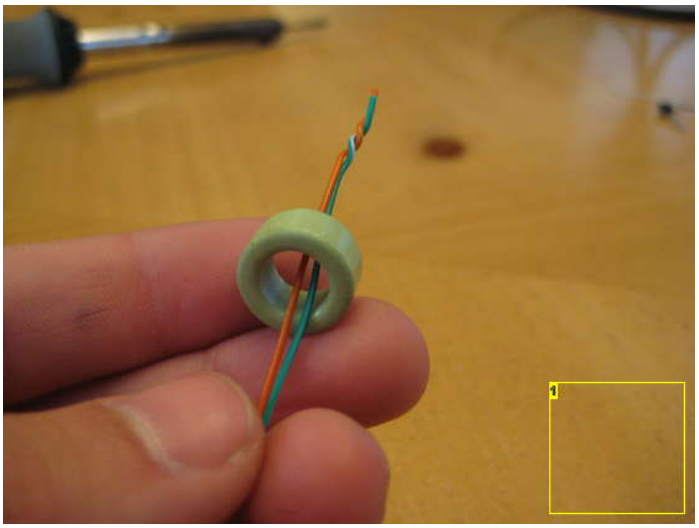


Image Notes
1. Put the wires through the center.

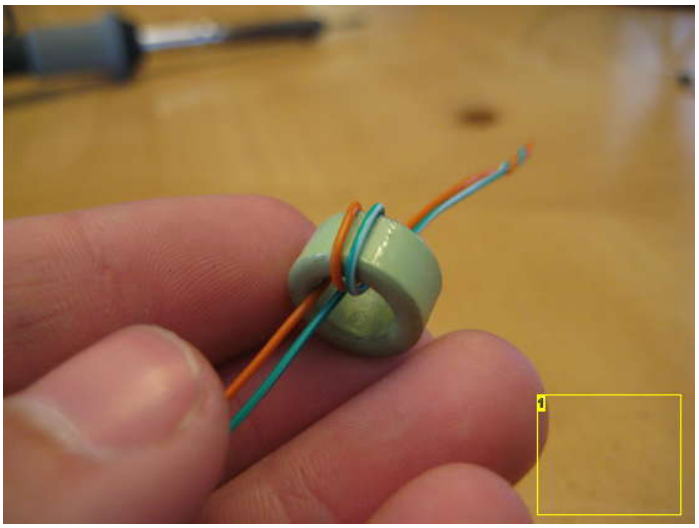


Image Notes
1. Wrap it around.

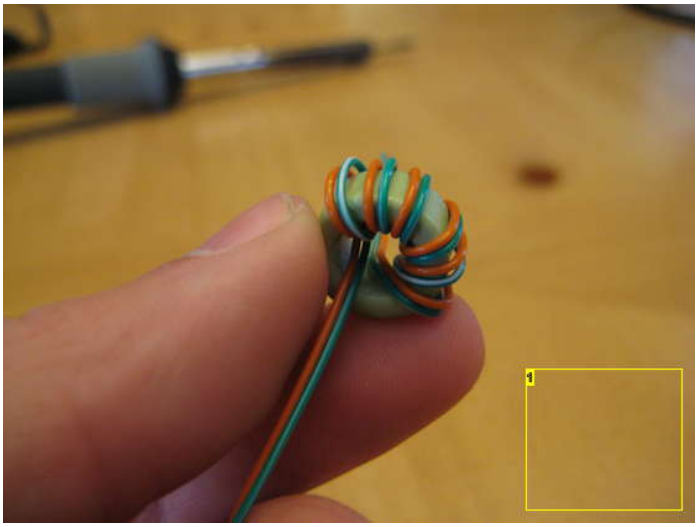


Image Notes
1. Halfway there...

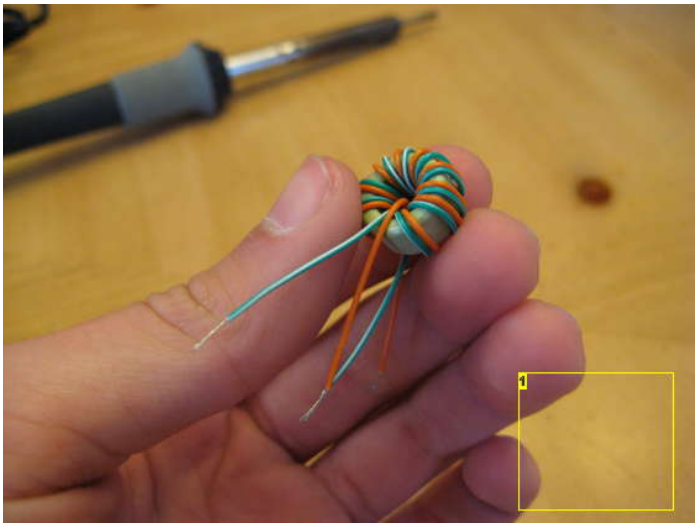


Image Notes
1. Finished toroid, with wires of the OPPOSITE COLOR from DIFFERENT SIDES

twisted together.

Step 3: Solder it all Together

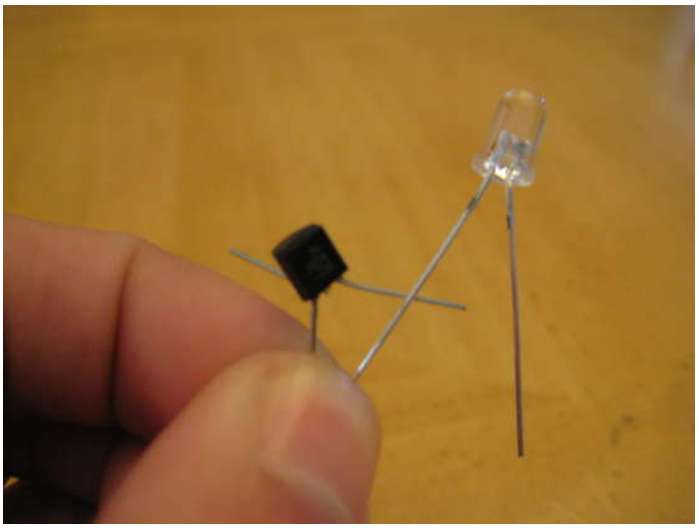
Now we are going to solder the whole thing together. You could put it on a board if you like, but in this Instructable, we're going to free-hand solder it. Or whatever you call it. You can follow these written instructions, or take a look at the pictures. They explain it very well.

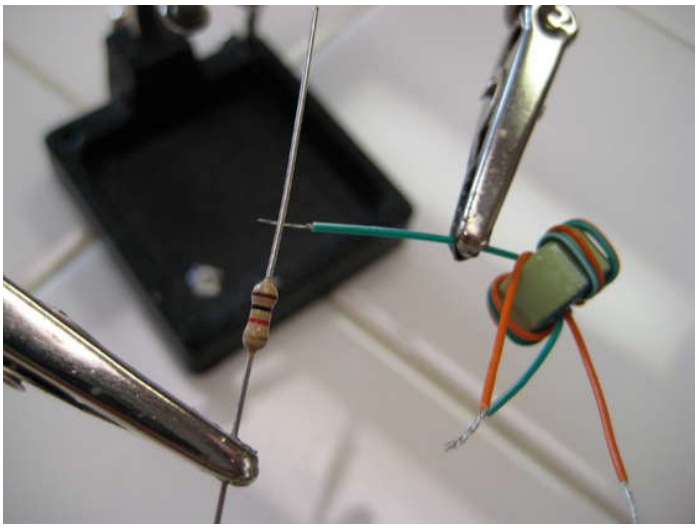
First, take the two outer leads of the transistor and bend them outwards a little ways, and bend the middle lead backwards. Bend the LED's leads outwards, too. You don't have to, but it makes it easier to solder.

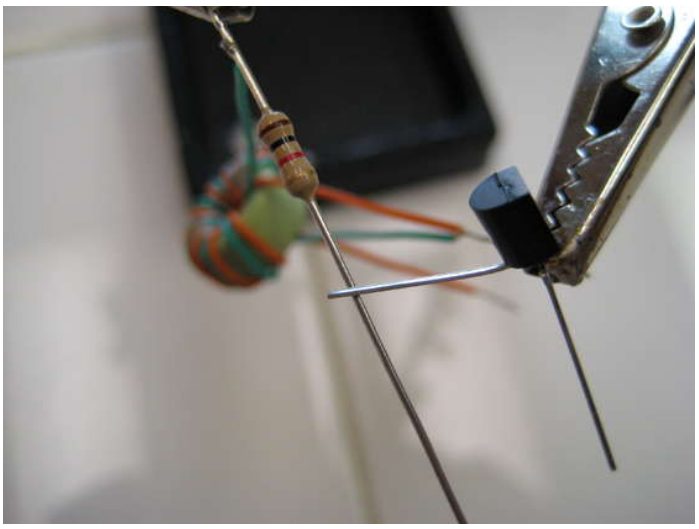
Take one of the wires coming from the toroid that is alone; that is, not twisted together with another wire. Solder it to one side of the resistor. Solder the other end of the resistor to the middle lead of the transistor.

Take the other single wire from the toroid, and solder it to the collector of the transistor. Solder the positive side of the LED to the collector as well, and solder the negative side to the emitter.

All that's left to do now is solder an extension wire to the negative side of the LED. Take a piece of that wire you had earlier and solder it to the transistor's emitter.







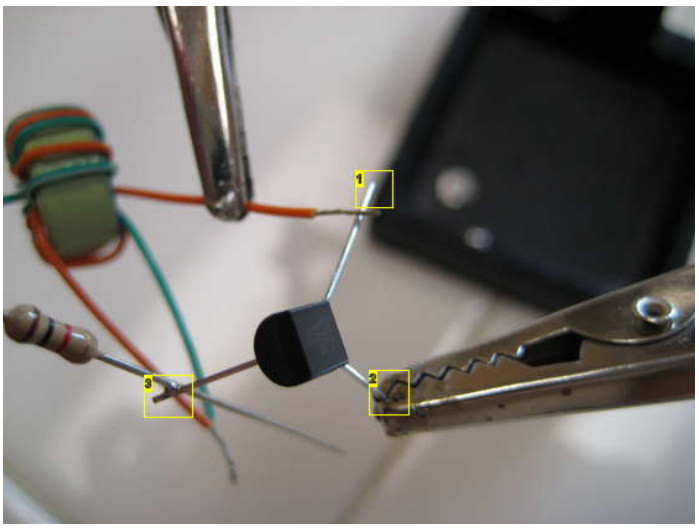
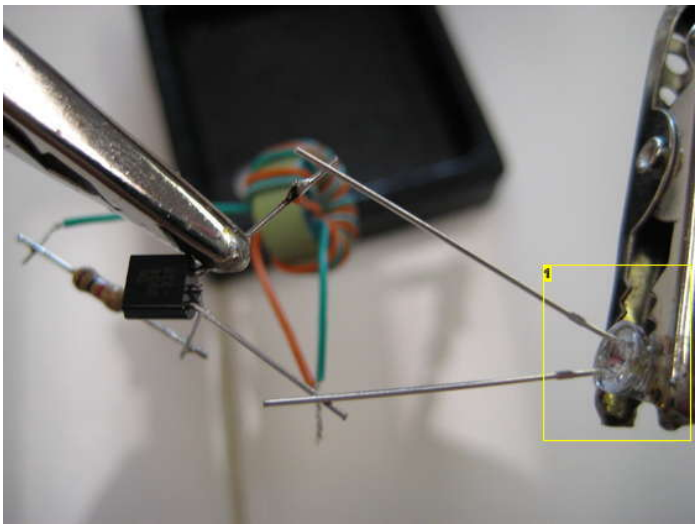


Image Notes
1. Collector
2. Emitter
3. Base



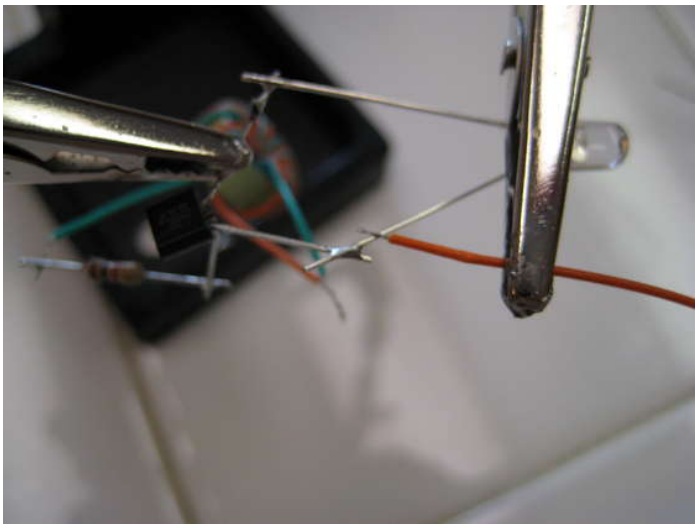
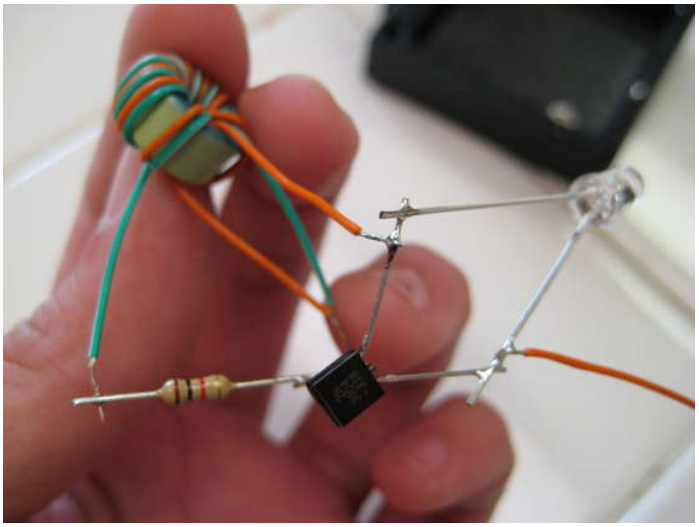
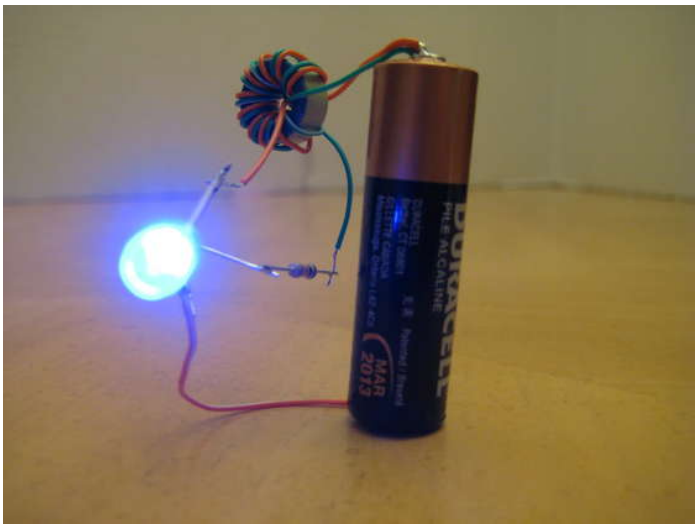


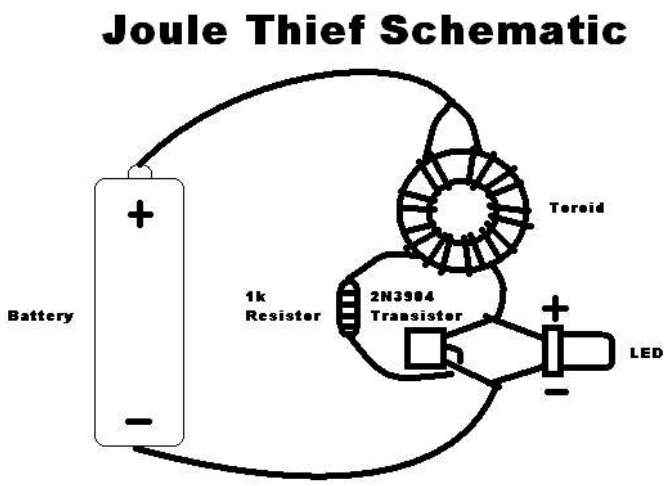
Image Notes
1. The negative side of the LED has a shorter lead.



Step 4: Try it Out!

And that's it! You're finished with your Joule Thief. Touch the twisted wires coming from your toroid to the positive side of a battery, and the extension wire to the negative side. If all is working well, the LED will light up! If not, try using thinner wire on your toroid. I've included a schematic in the pictures if you prefer.





Related Instructables

Joule Thief Charger by botronics

Ultraviolet Light Pen by junits15

Dollar Store Joule Thief! by aromaoftacoma

Electric Chair Joule Thief by Focker

The illuminated LED man (or The Joule Thief man) (Photos) by SpEcIeS8472

Joel the joule thief (Photos) by jaybird0123

Comments

50 comments **Add Comment** **view all 586 comments**

batman96 says: Mar 18, 2011. 11:16 AM **REPLY**

I just rebuilt the one I built a wile ago that didn't work and it works now, I am trying to decide to build a "dead battery flashlight" or a "dead battery night light" Turns out the transistor I had was either broken or pnp. I got a bread board so I just tried different transistors until it worked.
Thanks for the very detailed instructions!

chris28456 says: Mar 12, 2011. 9:24 PM **REPLY**

Great Project. Anyone know what gauge (awg) wire is suggested? also solid core vs. stranded does it matter? Thanks

ShemySheza says: Mar 6, 2011. 5:24 AM **REPLY**

thanks but 1 question-how many wounds of wire?just 10 or can i use more?does it matter?

lperkins says: Mar 5, 2011. 10:55 PM **REPLY**

It's perfectly possible to solder to batteries without any ill-effects. Commercial battery packs use spot-welding, and you want the heat characteristics to be as close to that as possible. Basically you want a high-power soldering gun. One of those little pencil irons is not going to cut it. In my experience, a good rule of thumb is to never put your iron to the battery for more than about two seconds, and then let it cool completely first if you have to hit it again. If you can't make it work that fast, you need a hotter iron. I can only speak for Alkaline, NiCd, and NiMh batteries. I wouldn't even try to solder things with "Lithium" anywhere in the name without good safety gear and a fume hood.

Indula says: Jan 29, 2011. 11:27 PM **REPLY**

can we use button cell

1up says: Feb 3, 2011. 6:43 PM **REPLY**

Sure, but don't solder to it. I can almost guarantee you it will explode.

Gepetto Father says: Mar 3, 2011. 6:28 AM **REPLY**

i've soldered button cells many times with no explosions involved. What does happen is the fast oxidation of the metal case, specially where i sand to get a cleaner sodering surface.

Of course, don't take too much time soldering it or it really might explode. Other thing to note is that they stay hot for like, centuries, after you heat them.

robot1398 says: Feb 21, 2011. 5:20 AM **REPLY**

i made it and it works very well.
i used a bc547 transistor

cool project

robot1398 says: Dec 26, 2010. 7:21 AM **REPLY**

can i use a bc547 transistor in place of 2n3904

robot797 says: Dec 26, 2010. 2:20 PM **REPLY**

all npn transistors work

when i build one
i get my junk box and desolder the firsth npn i see :P

also if you make the 1K resistor a 2 or 5 K pot you can tune it into the right frequentie

robot1398 says: Feb 21, 2011. 3:19 AM **REPLY**
thanks

spartans says: Feb 18, 2011. 9:41 AM **REPLY**
as the transistor turns on and off quite frequently wont it damage the LED being used.

Munchys says: Feb 16, 2011. 6:29 PM **REPLY**
My led requires 3.5v this wouldn't be able to power it would it?

Musicman41 says: Jan 19, 2011. 11:46 AM **REPLY**
what is the purpose of the toroid?

JoshuaZimmerman says: Jan 24, 2011. 7:28 AM **REPLY**
Wire wrapped in a coil creates a magnetic field when power flows through them (thats how electric motors work). In this case we get a magnetic field building up in the coil, when the transister switches the field collapses and the extra power it's build up gets flooded into the circuit. This then happens like 1000 times a second. This is how we're able to power a 3.6 volt LED off a 1.5 volt battery. To directly answer your question the toroid is just something for you to wrap your wires around, anything will do. I love using this circuit in combination with a solar panel to build weird solar lights. (I even have kits available for it on my website, browndoggadgets.com)

Munchys says: Feb 13, 2011. 7:30 PM **REPLY**
So could I use a super magnet with a hole in the middle instead of a toroid?

JoshuaZimmerman says: Feb 13, 2011. 9:46 PM **REPLY**
Just use a toroid. Or anything round really. A magnet might cause all sorts of issues, and be a big pain to work with around all these metal parts.

PatrickVallieres says: Feb 4, 2011. 6:52 PM **REPLY**
i us a button cell and a hollther from a old computer and a micro swech

axeman911 says: Jan 22, 2011. 12:39 PM **REPLY**
whats a toroid what is its purpose?

rayfalcon says: Nov 21, 2010. 6:20 AM **REPLY**
hey it works kind of! let me explain whats going on it blinks my led but will not keep it lit up and my battery gets extremely Hot so i quit using the one i just made and taking some time to try and get help on itthe 1 k trans might be wrong on mine its a clear glass thing with Brown black and red on it but its glass and on one side it says 48 thats all it has on it.....Is that a 1k trans or is this a diode? if so can that be the problem?
Charles

1up says: Nov 21, 2010. 9:49 PM **REPLY**
It's a diode if it's glass. :P Look up some diodes and resistors on Google images so you can tell the difference.

kcarring says: Jan 7, 2011. 12:39 AM **REPLY**
+maybe it is a 1n4147 diode. resister shouldn't be glass. if it looks like this: http://tinyurl.com/27l63z6 it's a diode

thomas53 says: Dec 21, 2010. 7:25 AM **REPLY**
Works perfectly :)

rhanson294 says: Dec 1, 2010. 8:07 PM **REPLY**
Not to be offensive, but I have always been told that you never solder to a battery. In some of the pictures it looks like the wire is soldered directly to the battery. Just wondering how safe that is.

luiscll says: Dec 6, 2010. 12:56 PM **REPLY**

I think that with a pair of magnets the soldering can be avoided. Just an idea to who wants to avoid soldering.

thomas53 says: Dec 21, 2010. 7:24 AM **REPLY**

Or just use a battery holder

threewheela says: Dec 4, 2010. 10:29 PM **REPLY**

its plenty safe as long as you dont overheat the battery because it could explode and everyone knows heat is bad for battery life anyway

1up says: Dec 2, 2010. 7:07 PM **REPLY**

It does looks like that. I actually slid the wire under the plastic cover on the battery to hold it in place, and the bottom wire is just being sat on by the battery.

You are right, you should never try to solder to batteries.

beehard44 says: Dec 2, 2010. 4:11 AM **REPLY**

just do it quickly and never using a button cell

robot1398 says: Dec 18, 2010. 7:11 PM **REPLY**

how thick wire we have to use to wind on the toroid

scraptopower says: Dec 9, 2010. 1:47 PM **REPLY**

If you've built this and it doesn't work, try reversing one of the phases on the toroid. I built two neither of which worked. I read on another site that if it doesn't work but is drawing current (mine drew 50ma without lighting the LED) then one of the phases of the toroid must be the wrong way around. Now it draws 39ma and lights up the LED!

So I reversed one phase in both of my joule thieves, and they work brilliantly now! The LED is blinding!

Thanks for the great instructable!

batman96 says: Dec 15, 2010. 10:41 AM **REPLY**

I got Joule Thief I built that doesn't work, every part is good, I got a multimeter, how do I check if it is drawing any current? And if it is how do I "Try reversing one of the phases on the toroid."???
Thanks.

1up says: Dec 11, 2010. 11:26 PM **REPLY**

Thanks for the tip! I think I'll add that with credits to you. It should help a lot of people. If I'm understanding this right, you just need to reverse the two wires coming out of the toroid (going to the transistor and resistor) and it should work fine?

scraptopower says: Dec 12, 2010. 1:57 AM **REPLY**

No, I actually reversed one of the of the coloured wire completely. I took one of the wires from the end that was twisted and connected it to the resistor, and then I took the wire that was originally soldered to the resistor and connected it to the other wire that was twisted. So completed reversing one colour of the toroid.

This makes no sense why it worked, as the way you wound the toroid both the phases should be the right way. But it worked...

1up says: Dec 13, 2010. 5:37 PM **REPLY**

How interesting... I'll have to give it a try if it doesn't work.

batman96 says: Dec 13, 2010. 4:47 PM **REPLY**

From what I understand this is a simple transformer. So could you use something metal for the core, like a thick washer?

1up says: Dec 13, 2010. 5:36 PM **REPLY**

Probably. You can even use air, or a rusty nail:
http://hackedgadgets.com/wp-content/_rusty_nail_led_project.jpg

batman96 says: Dec 14, 2010. 9:52 AM **REPLY**

Thanks, a couple of more questions though.
1) For doing it with the nail, do you go down the nail then back up with the wire?
2) In the image what does the Cap do?
3) How do you do it with air?
4) From what I understand the power going to the LED is AC, because of the on/off from the transistor, so could you run the power through a diode rectifier to run other stuff, or would you need some caps to make the current continual?

Sorry about having so many questions I don't know much about circuitry but would like to learn, and I thought this would be a good one to build.

Dreistein says: Dec 9, 2010. 11:37 PM **REPLY**

how high is the voltage of the battery and joule thief?

1up says: Dec 11, 2010. 11:27 PM **REPLY**

The joule thief puts out about 3.0v and will run on anything from 0.6-3.0v, depending on how well you make it.

buju357 says: Dec 10, 2010. 2:36 PM **REPLY**

see here how I made a 6 led joule thief torch.

h**p://buju357.blogspot.com/2010/12/6-led-joule-thief.html

GarbageMan500 says: Dec 3, 2010. 7:27 PM **REPLY**

Make a Joule Thief. I see what you did there.

freakyqwerty says: Dec 5, 2010. 10:26 AM **REPLY**

I don't.

xAxrules says: Dec 3, 2010. 12:05 AM **REPLY**

Could you make a proper schematic please?

bambangpe says: Dec 2, 2010. 12:27 AM **REPLY**

inspire me...

metroid62 says: Jul 5, 2009. 7:53 AM **REPLY**

Ah yes, I'm about to get the parts for this, I'm excited because this is going to be my first minor project that involves batteries and LED's.

geekman101 says:
same here i found that i can get all the parts for $4.86 from my local jaycar

Jul 4, 2010. 1:55 PM **REPLY**

Jimmy Proton says:
thats a lot more than i would pay for some thing like this

Dec 1, 2010. 6:19 PM **REPLY**

zack247 says:
will this work with normal thin wire? or what about the wires originally on the toroid?

Nov 12, 2010. 5:43 PM **REPLY**

1up says:
Yeah, either should work.

Nov 17, 2010. 1:08 PM **REPLY**

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