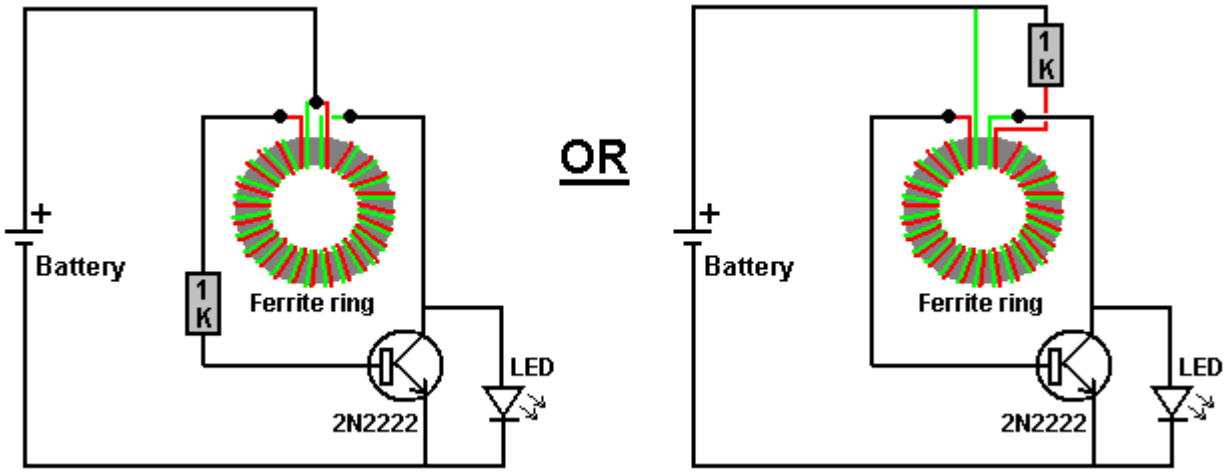
The "Fleet" ("Forever Lead-out Existing Energy Transformer") device is a self-powered electrical generator which has no moving parts and which can be constructed cheaply. It has been developed by a Hong Kong based team of people: Mr Lawrence Tseung, Dr. Raymond Ting, Miss Forever Yuen, Mr Miller Tong and Mr Chung Yi Ching. It is the result of some years of thought, research and testing and it has now reached an advanced stage of testing and demonstration and is nearly ready for commercial production.

Mt Tseung has applied his "Lead-out" theory to the category of low-power circuits known as the "Joule Thief" circuits. These circuits originated with an article by Mr Z. Kaparnik, in the "Ingenuity Unlimited" section of the November 1999 edition of the "Everyday Practical Electronics" magazine.

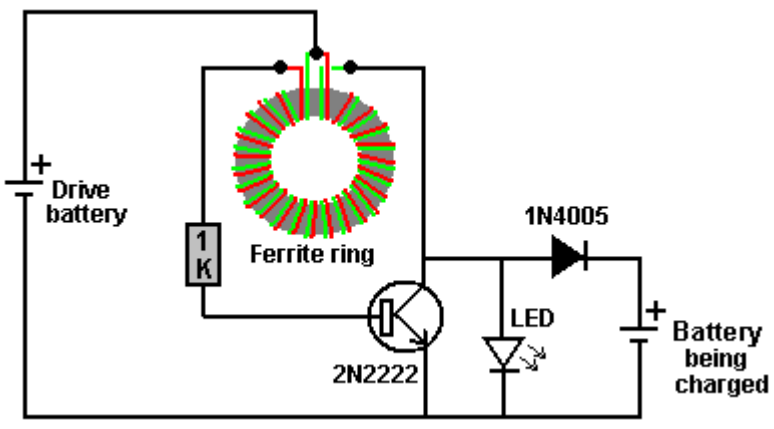
The initial circuit allowed the very last energy to be drawn from any ordinary dry-cell battery, and used to light a white Light-Emitting Diode ("LED") for use as a small torch. It allows a battery which is considered to be fully discharged, to drive the circuit until the battery voltage drops right down to 0.35 volts. The initial circuit uses a bi-filar coil wound on a ferrite ring or "toroid". Bi-filar means that the coil is wound with two separate strands of wire side by side, so that each adjacent turn is part of the other coil. A coil of that type has unusual magnetic properties. The Joule Thief circuit is like this:



It is important to notice how the coil is wound and how it is connected. It is called a "toroid" because it is wound on a ring. The ring is made of ferrite because that material can operate at high frequencies and the circuit switches On and Off about 50,000 times per second ("50 kHz"). Notice that while the wires are wound side by side, the start of the red wire is connected to the end of the green wire. It is that connection which makes it a "bi-filar" coil instead of just a two-strand coil.

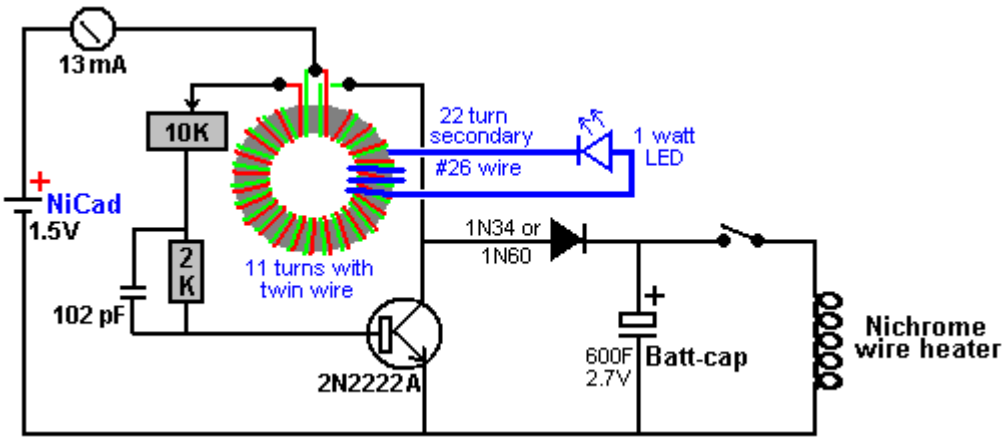
This "Joule Thief" circuit was then adapted by Bill Sherman and used to charge a second battery as well as lighting the Light-Emitting Diode. This was achieved by adding just one more component - a diode. The diode used was a 1N4005 type because that was to hand at the time, but Bill suggests that the circuit would work better with a very fast-acting Schottky-type diode, perhaps a 1N5819G type.

The circuit produced by Bill is:



When driven by a 1.5 single cell battery, this circuit produces about 50 volts with no load and can supply 9.3 milliamps of current when the output is short-circuited. This means that you could charge a 6-volt battery using a 1.5 volt battery.

"Gadgetmall" of the www.overunity.com Joule Thief forum has taken the circuit further and found a very interesting situation. He has modified the circuit and used a "batt-cap" which is a very high capacity, very low-loss capacitor. This is his circuit:



He has added an additional winding to his one-inch (25 mm) diameter ferrite toroid, and he uses that to power a 1 watt LED. Why he has done this is not immediately clear to me, except possibly, that it shows when the circuit is operating. He runs the circuit driven by a small rechargeable battery, which feeds 13 milliamps into the circuit, for a period of fourteen hours. At the end of that time, the batt-cap has gathered enough energy to fully recharge the driving battery in a minute or two, and then power a heater winding of nichrome wire (as used in mains-powered radiant heaters) for four and a half minutes. Alternatively, that amount of extra power could boil a kettle of water. The really interesting thing about this is that the driving battery gets recharged every time and so the circuit is self-sustaining although it is not a powerful circuit.

Mr Tseung has taken the Joule Thief circuit and modified it to become a circuit with a very serious output, moving it into a completely different category.

As a first step towards what the team calls their "Fleet" device, the toroid has been enlarged to a much greater diameter. The coil is now wound on a section of plastic pipe, 170 mm (6.5 inches) in diameter and 45 mm (1.75 inch) deep:

This section of pipe is "bi-filar" wound with two wires side by side as already described for the Joule Thief construction. As before, the start of one wire is connected to the end of the other wire. Then, the winding is given a layer of electrical tape to hold it in place and to provide an easy working surface for a second winding.

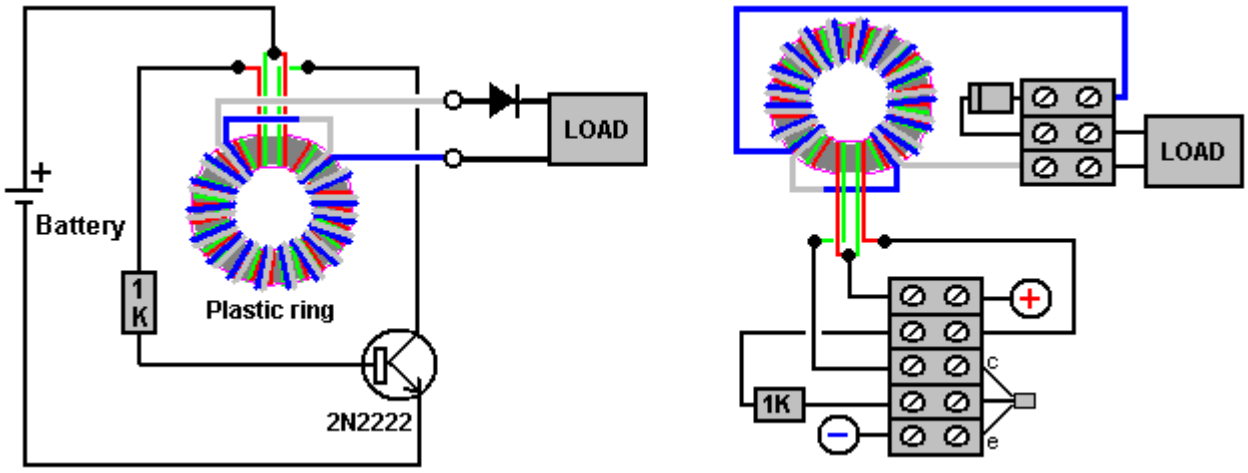
The wire used for the winding is the widely available red and black pair of wires, sometimes called "figure of eight" because the cut end of the wires looks like the numeral 8. The wire should be able to carry 2.5 amps. It must be side-by-side wire and **not** one of the twisted varieties. It looks like this:

The second winding is made in the same way but the connections are slightly different. As before, the end of the first wire is connected to the start of the second wire, but that connection is then insulated and not used in the following circuitry. This just connects the two windings one after the other, known technically as being connected "in series" and is the equivalent of making the winding with just a single strand of wire. The completed coil may look like this:

This particular design is still in it's early stages and so many different coils sizes and constructions are being tested:

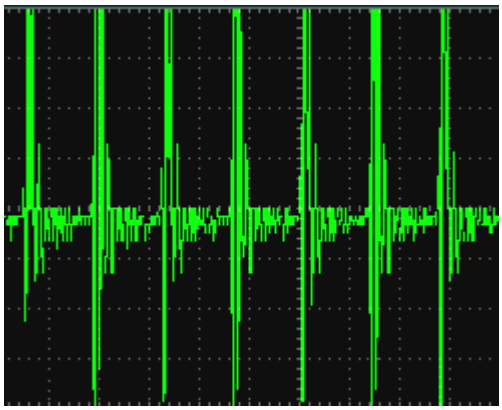
The arrangement is for the inner winding of the toroid to be oscillated by the Joule Thief circuit already described. This causes a pulsating magnetic field to envelope the outer winding of the toroid, producing an electrical output which is capable of doing useful work. The really important thing about this arrangement, is the fact that the amount of power coming out of the circuit is very much greater than the amount of power needed to make the circuit operate. The additional power is led out of the local environment and drawn into the circuit, becoming available to do useful work.

The overall circuit then looks like this:



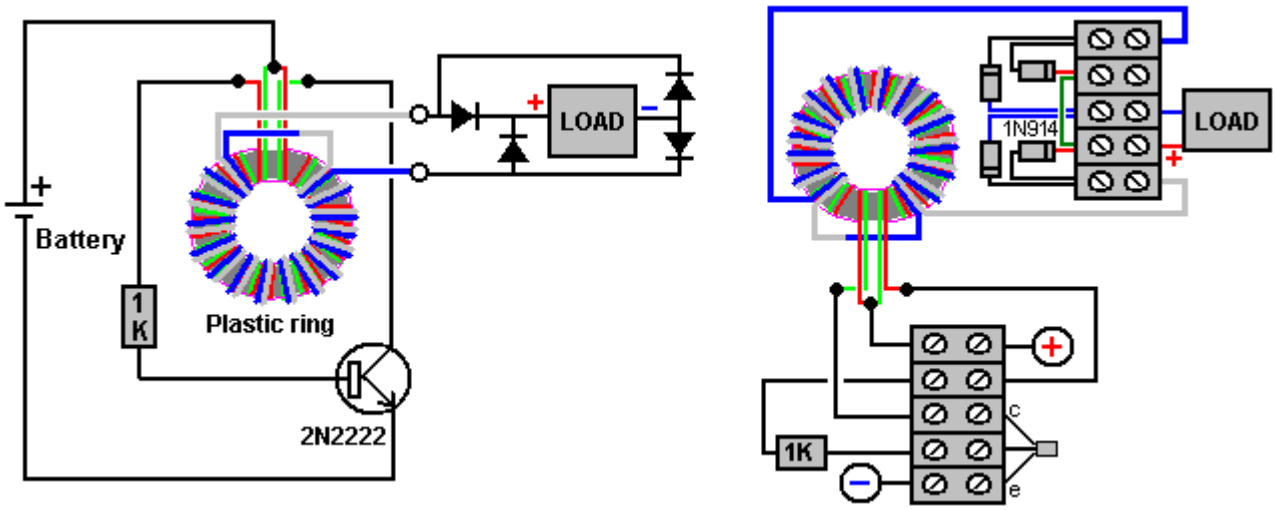
While the outer winding is shown here with thicker wire of a different colour, this is only to make the arrangement easier to understand. In reality, the outer winding is with exactly the same wire as the inner winding, and it will normally go all the way around the toroid. The total amount of wire needed to make the windings is about 70 metres and so it is normal to buy a full 100 metre reel of the twin-core wire, which allows both windings to be made and leaves spare wire for other things.

For those of you who are **very** technically minded, the output waveform looks like this:



and the voltage pulses in this output are occurring about 290,000 times per second.

What has worked better for me is using a bridge of four diodes rather than a single diode:



I have used this circuit, driven by a 1.5 volt battery, to charge 12-volt batteries, but the best results are in the five to six volt range.