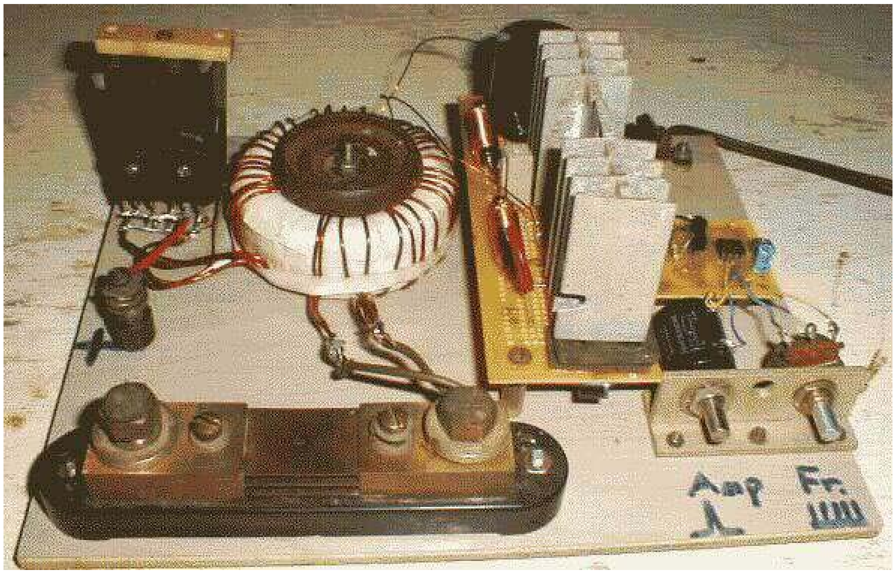
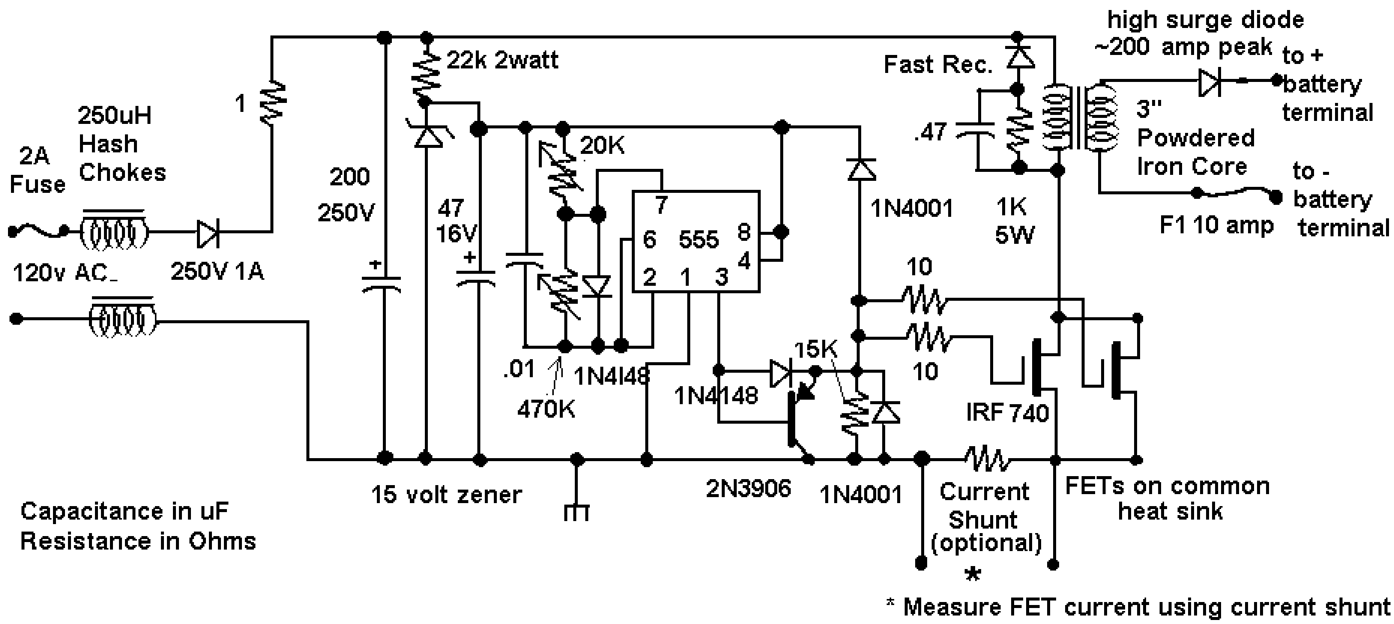
High Power Desulfator

Beta level Circuit

(Updated April 11, 2002.) The following circuit is looking like it will give good results for large battery banks, as it is putting out ~200 amp pulses at 12 volts. While I am not necessarily recommending this high level, it should answer the needs of the biggest of banks. This will also give a low level charge of a few amps, given the low rep rate. It is still being tested at the moment, but I do not expect large departures from this basic layout.





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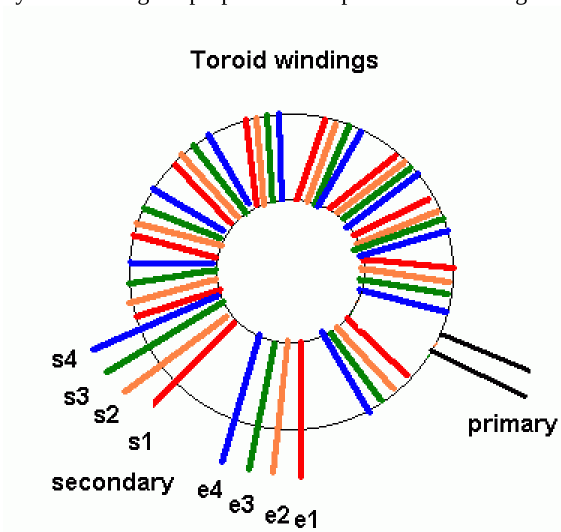
Dangerous voltages present - experiment carefully

Here are some design factors and parts suggestions, starting from the left:

- The circuit runs directly off line power, no transformer. This means dangerous voltages are present ! Experiment carefully. The 1 ohm resistor is to limit inrush current when turned on. The fuse should be a slow blow type. The hash chokes are for reduction of radio interference. The circuit would be best built in a shielded box if this is a concern.
- The driver circuit runs off of high voltage stepped down and regulated. The zener and the 22k resistor will get warm during operation, but not hot. If they get too hot, increase the 22k.
- The 555 circuit is much the same as with the low power pulser. I now use the enhanced turn off circuit contributed by Ron Ingraham, as it is simplest. Since the drain current is zero when the FETs turn on, it does not matter if the drive is slower at that point. Only turn off speed

matters for maximum effect. The pulse width is anywhere from 10 to 100uSecs, depending on what is desired for peak output current.

- The output FETs are paralleled together on a common heat sink. They get only slightly warm during operation, so it does not need to be large. At the moment I am using 3 IRF740's, this is probably on the safe side as they do not get warm. Other FETs can be used if they have low on resistance and a 400 volt rating.
- The snubber circuit uses a fast 200V diode, a 1k 5W resistor, and a .47 250V capacitor. This is a traditional approach to limiting peak transients, and works well enough. The dissapation here can be reduced as the transformer is further optimised.
- The transformer is wound on a core from **Bytemark.** It is powdered iron, 3 inches in diameter, part number T-300A-26. One could probably use the next size down as well. The primary is at the moment 60 turns of no. 18 to 20 enameled wire. Cover the primary with a layer of insulation, preferably of transformer tape (or at least not black electrician's tape.) There are four secondary windings of ten turns each, no.12 or14 wire. They are wound in "quadra-filar" fashion, which means they are placed side by side and wrapped around together in the form of a ribbon. The windings should all be evenly spaced and spread uniformly around the circumference of the core. This is done to reduce stray inductance. Note the polarity of the windings. All the windings are done in the same direction. The primary lead which connects to the high voltage line will be a beginning point. The secondary winding which connects to the diode will therefore also be a beginning point. If the polarity of the secondary is reversed, then you will not get a proper current spike. Here is a diagram to show this:



- For 12 volt batteries, use all the secondaries in parallel, ie. S1, S2, S3, S4 are all tied together, and E1, E2, E3, E4 are all tied together. For 24 volt batteries, use series connections to increase the voltage, just like a normal transformer. This means use the windings in pairs, and connect the ending of one paired winding to the beginning of the other, ie S1-S2 is connected together, E1-E2 and S3-S4 are all connected together (the center tap, which is not otherwise used), and E3-E4 are connected together. For 48 volts systems, use the four windings in series, or S2 to E1, S3 to E2, S4 to E3, S1 and E4 are the output leads. Note that the peak current will be reduced at the higher voltages. For 120 volt EV batteries, a more straightforward 1:1 transformer should work, with primary and secondary each made with #12 wire. The windings would be made in bifilar fashion.
- The output rectifier is a high current, reasonably fast type. At the lowest voltage, a Schottky diode, such as the 60 amp 45 volt STPS6045CW from ST Microelectronics gives good efficiency. (Mouser catalog part no. 511-STPS6045CW) . Mount it on a small heat sink. At higher voltages, try a 20 amp 100 volt STPS20H100CW, which has lower current but higher voltage rating. They can be paralleled for higher current. At the highest voltages, 400 volt, 35 amp fast recovery units are needed. It is important to have a load connected before applying power, otherwise the FETs could receive a damaging spike.
- The theory behind this type of circuit can be seen on this page of DC to DC converter designs.

Adjust the circuit with the variable resistors on the 555: The 470K resistor adjusts rep rate, and should be set to less than 1kHz. The 20k resistor is pulse width, and should be set such that the transformer core is not starting to saturate- in the neighborhood of 100 usecs. The circuit as a whole should draw around .2A @ 120VAC or less. In my tests on the bench I can get over to 200 A peak current out at low voltage. Less peak current will be possible at the higher voltages. However, one only needs to duplicate the transformer, and add more FETs in parallel to get further increases in peak power.

Be careful in probing the circuit with a scope. I have been advised that a half wave rectifier, at the line input, should be used so that people won't get confused by creating ground loops with scope probes, etc. It seems that the full wave bridge is not really needed as ripple is not much of a concern with this circuit. Make sure that you observe correct polarity at the mains connection point, so that ground is indeed grounded.

For those who wish to drive this circuit from a microcontroller chip, use an optocoupler for protection. The following diagram will enable a simple logic level interface, using the Isocom H11L2 (from Digikey.) This unit has a strong pull down output, and is reasonably fast. Other types will be fine, as long as they have a low turn current input(10mA or less) and a fast darlington or schmidt trigger output.