Xenon flasher for pushbike riders

If you go riding your pushbike on a dark night during a power blackout, you'll need this project. Even if you just ride your bike at nights, being visible to other vehicles is important for safety. A bright flashing light will see to that.

Jonathan Scott

THIS IS an idea which is only just catching on in the US (so who knows how long it will be before it gets proper commercial release here), and it's a good thing indeed. Let's face it — bicycle lights are pretty useless for seeing things, but they serve the valuable purpose of letting the rider *be seen*. It is also not a recent realisation that a xenon flash is easily seen at a distance and potentially very power economical, which is what you want if you have to purchase (and carry) the batteries.

So here it is: the low-cost, high visibility bicycle flash. It will flash for many hours on one single cell, a Nicad being best as you only have to pay about ten times the initial price for 100-500 times the life.

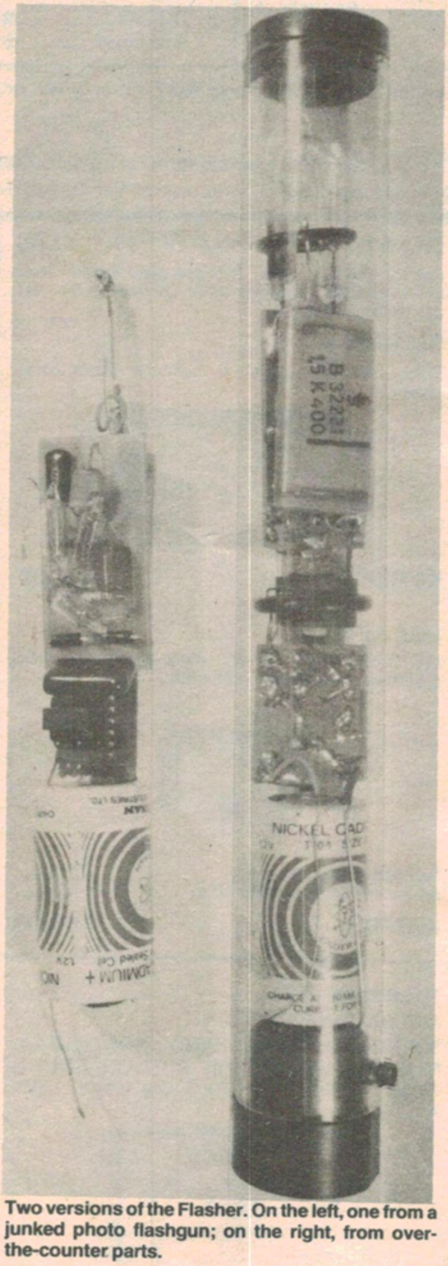
Our prototypes, one constructed using a dismantled $10 flashgun and one from commercial electronic suppliers' parts, ran for 15 hours and 8 hours at 1 Hz and 4 Hz respectively, on $7 Nicads. One quarter of this can be expected from $2 Nicads.

The unit can be recharged from any convenient source including the ETI-563 Fast Nicad Charger, a bicycle dynamo, or the charger we include in this project.

Bits and pieces

As we mentioned before, we have built one 1506 using parts from a $10 flashgun purchased expressly for this purpose. The advantage of this is that you get the xenon tube, trigger transformer and neon lamp all customised and prepacked. You also get a prewound converter transformer, though we recommend that you wind your own, as we did, as the result is about twice as power efficient.

Alternatively the project can be made entirely from easy-to-find parts, with one small circuit modification. Perhaps at this stage you are rather confused by all the options, so let's break the project up into its two basic sections and describe how you go about each part.



Two versions of the Flasher. On the left, one from a junked photo flashgun; on the right, from over-the-counter parts.

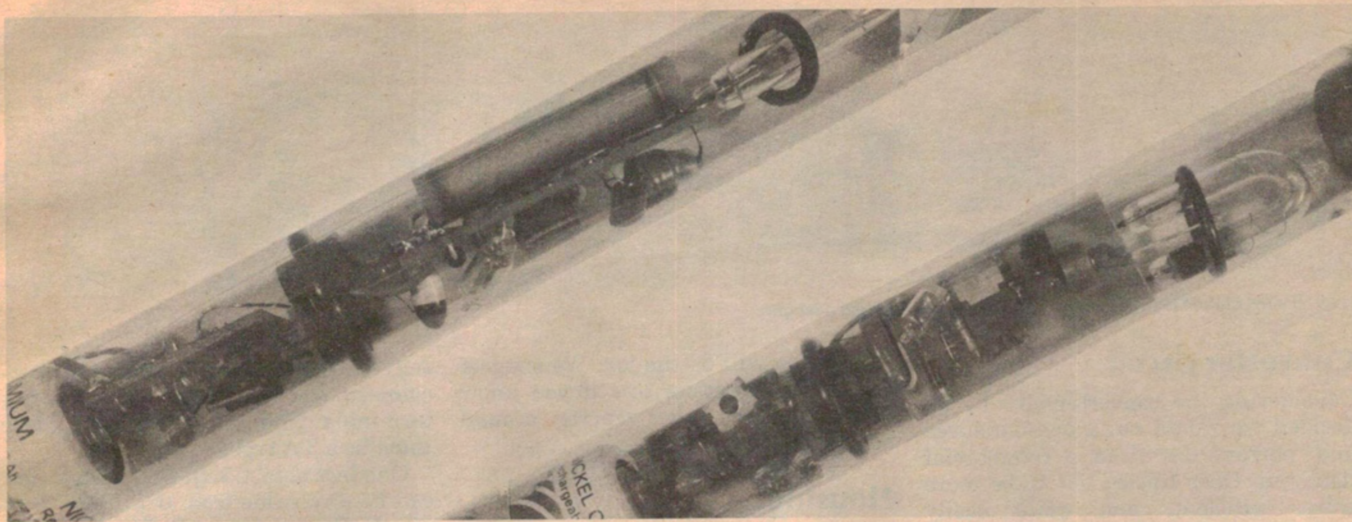
Our preference

Referring to the circuit in Figure 1, which is our preferred and recommended circuit, you see that it is composed of a dc-ac converter board (taken directly from the ETI-575 Light Wand) and its transformer, and an ac-dc flash driver board. Starting with the latter, if you then have or purchase a cheap flashgun, you will also have the tube, trigger transformer and 220 V neon.

The small flash-type xenon tubes seem to be slightly more light-efficient than the 'U'-tube type locally sold, and are less easily broken, so we prefer them. If you don't get hold of it this way you may have difficulty getting the neon, so we have made provision on the pc board for using three of the local 70 V type (NE2) in series, in place of the single 220 V one.

An advantage of using the 220 V tube is that it delivers a non-regular flash rate, which we feel improves recognisability and reduces risk of confusing you on the bicycle with any other flashing light. We won't go into the physics of why the xenon tube does this, but suffice it to say that the 70 volt types do not have sufficiently significant erratic factors to give a visibly varying rate over short time periods.

If you use the three neons in series, you will have to cut off the SCR's heatsink tab to make the necessary room. This is quite safe, as it dissipates negligible power. See the two overlay diagrams for details of this. The tab can be removed by hacksaw, side cutters or simply by bending it until it fatigues, as it is made of thin, soft metal. This should present no problem. ▶



Inside views of the 'preferred' flash unit.

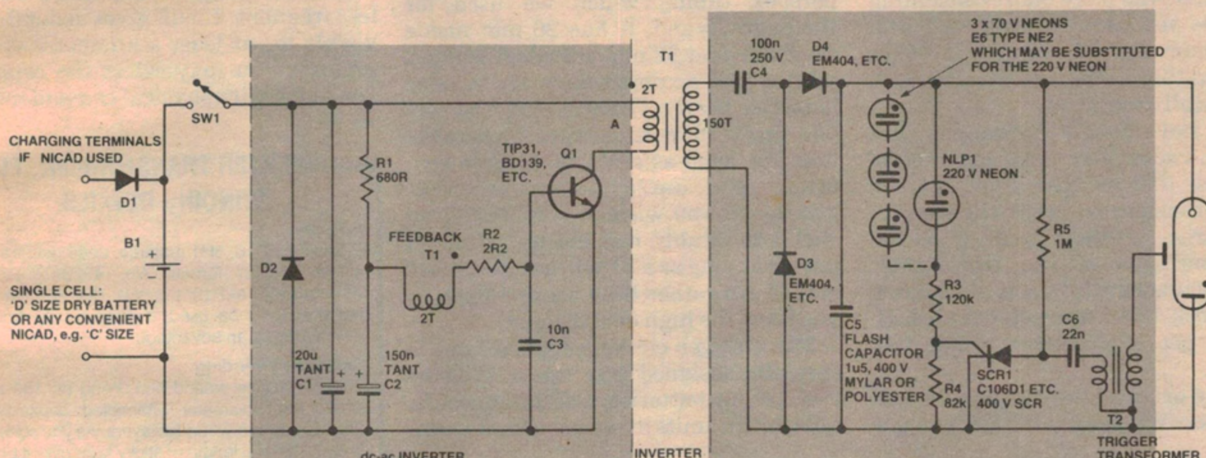


Figure 1.

HOW IT WORKS — ETI 1506

There are two major sections to the circuitry: first the dc-ac inverter, followed by the xenon flasher.

INVERTER

This employs the inverter circuit from the ETI-575 Light Wand (ETI, Aug. '79). This section of the circuit is shown on the left in Figure 1. R1, R2, C2, C3, Q1 and T1 comprise a self-oscillating dc-ac inverter.

Initially, Q1 is turned off. At switch-on, current flows through R1, charging C2. Subsequently C3 charges up via the feedback winding and R2. When C3 reaches about 0.55 volts, Q1 begins to conduct. The feedback winding then forces more current into C3 via R2 because of the phase of its connection. Q1 is then turned hard on. During this positive feedback cycle C2 is actually forced to discharge. R2 limits the maximum base current, and C3 removes fast spikes from the base circuit. These together serve to protect Q1's base.

Eventually, the magnetic field induced by the collector current of Q1 in the primary ceases to increase and the positive feedback ceases. Q1 then begins to turn off and the magnetic field in the core begins to collapse. This produces a negative voltage across the feedback winding which biases Q1 hard off. Then the cycle repeats, R1 and C2 defining the frequency and the power delivered to the tube, since a constant amount of energy (equal to I^2 max times L) is transferred to the load each cycle.

XENON FLASHER

This part of the circuit is shown on the right in Figure 1. C4, C5, D3 and D4 form a 'diode pump', which rectifies the ac output from the secondary of T1 and will 'fill' C5, the 'reservoir capacitor', after a number of cycles, raising the voltage across it to the peak-to-peak input voltage. On negative excursions of the voltage from the secondary of T1, C4 charges via D3. On positive excursions, the charge in C4 is transferred via D4 to C5, and C4 is reverse charged. The period taken to charge C5 is of course dependent on its capacitance and the peak input voltage, which varies because of the inverter's output impedance. However, C5 will, after some time, exceed the 'breakover' voltage of the neon, NLP1 (or the string of three neons). This then conducts, triggering the gate of SCR1, via R3/R4. Resistor R4 prevents false triggering of the SCR by tying it to the cathode with a relatively low impedance.

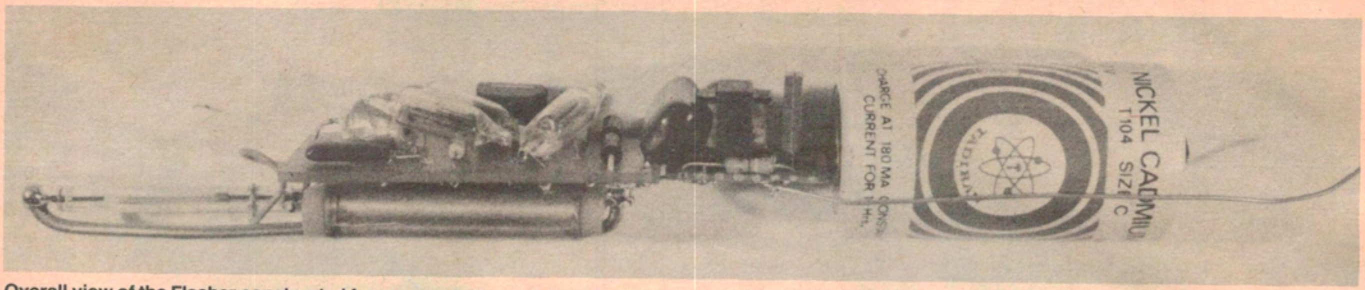
Before SCR1 triggers, C6 will have charged up to the supply voltage on C5, via R5 and the primary of T1. When SCR1 fires it suddenly connects C6 directly across the primary of T1, whereupon C6 discharges rapidly, producing a large voltage spike at the secondary. This is connected to a 'trigger' electrode wrapped around the outside of the xenon flash tube, and the voltage stress produced causes the gas inside the tube to ionise. Current then flows between the anode and the cathode of the xenon tube, the gas emitting much light in the process. The current flowing in the xenon tube discharges C5. When the voltage on C5 falls far enough, the xenon tube cannot maintain ionisation and it ceases conducting, as does NLP1. The SCR1 will also return to the non-conducting state as less than the anode-cathode latching current required flows through R5. Thus C5 starts re-charging and the whole cycle repeats.

The point at which NLP1 ionises varies with the immediate electrostatic field it is experiencing and also with the ambient radiation level, as these are significant factors in the ionisation process in neon lamps of this type. Thus flashing is erratic when a 220 V neon is used.

The function of diode D1 is to prevent B1 discharging via the charging terminals if they are accidently shorted, while D2 protects Q1 in the event of reverse polarity connection of the battery. (This is particularly likely if you ever use dry batteries, as they are changed often and it's easy to slip them in a battery holder the wrong way round.)

Capacitor C1 provides a low impedance bypass for the supply rail.

Project 1506



Overall view of the Flasher constructed from a cannibalised flashgun.

Converter circuit

Considering the converter circuit, we decided we would build one ourselves and 'borrow' one from a commercial flashgun. Ours turned out to be more power efficient, and quite easily adapted to using only 1.2 V of supply. It is, of course, the more effort-consuming option, as you have to wind your own transformer and make up an ETI-575 pc board, but this is the more pleasing way, electronically speaking.

If you have bought a flashgun that uses one, two or four cells, you must of course use that number if you want to use its transformer. You will have to quickly trace out their circuit to get the pin connections of the transformer before you dismantle it. It is almost certain to look like Figure 2, from which you can get a converter circuit like Figure 3.

Use the original transistor(s) as well if you like. We used a BD139 to show that it too will do the job. We suggest you only undertake this if you know what you are doing tracing around someone else's pc board.

Housing

We elected to build our units in the same perspex tubing which we used for the Light Wand. It has 26 mm inside diameter and 32 mm outside diameter, and so just accommodates the 'C' size batteries neatly. There is no reason why you can't build it in any transparent housing, such as a plastic kitchen container, and use a battery larger or smaller as you wish. A penlight Nicad will comfortably run the unit, though not for as long as a 'C' cell, as its capacity is 0.45 Ah rather than about 1.8 Ah (if you have the high density ones).

The charger circuit supplied here is specially designed to charge a single or two 1.8 Ah batteries, and is thus suitable for the units as we have built them.

A dynamo on a bicycle may also be used, connected directly to the charging terminals. The series charging diode must be a 3 A type.

One last note. C5, the flash capacitor, can be any value from 0.5 uF to about 10 uF. We used 1.5 uF. The larger its value, the brighter the flash, but the less frequent. 1.5 uF gives about 3-4 Hz, visible for at least a kilometre of open ground. You may select the capacitor you use for its physical convenience, as we did.

INVERTER TRANSFORMER, T1 WINDING DETAILS

Potcore

Phillips P26/16, 3H1 material, ue68 potcore with single section former, No. 4322-022-28250. Alternatively, a P18/11, 3H1 material, ue1750 potcore could be used. It is physically smaller, which may be an advantage.

Secondary winding

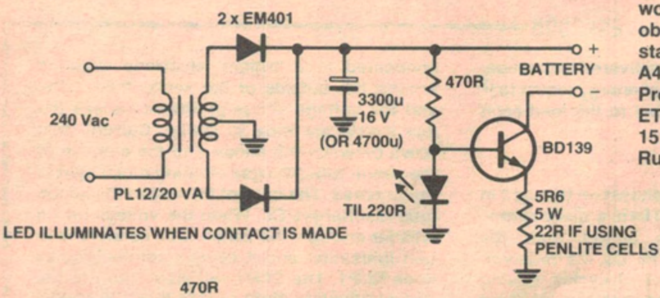
This should be wound first. Wind on 150 turns of 0.2 mm diameter enamelled copper wire (32 B&S), close-wound in layers. As you complete a layer, wrap a length of sticky tape over it before winding the next layer. You'll take about four to six layers. Put a layer of sticky tape over the completed winding.

Primary and feedback

These are wound *bifilar* — two lengths of wire wound side by side. Two turns are required. Use any convenient wire diameter greater than or equal to 0.5 mm (e.g: 22 B&S enamelled copper). **Note:** Mark the *start* leads of each winding — these correspond to those points on the circuit marked with a '•'.

If you've never done this sort of thing before, the article on the ETI-575 Light Wand (August '79) gives a detailed description of the sort of technique employed.

Charger for Nicads suitable for the Flasher



NOTE: Printed Circuit artwork for this project can be obtained by sending a stamped, self-addressed A4-sized envelope to: Project 1506 Artwork ETI Magazine 15 Boundary St Rushcutters Bay NSW 2011

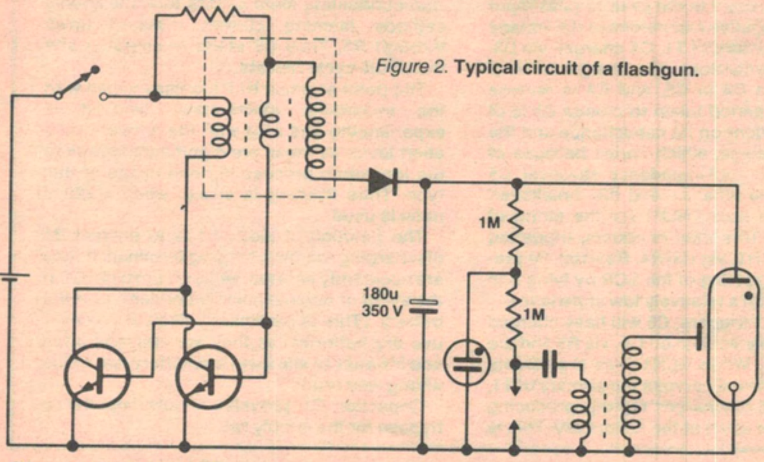


Figure 2. **Typical circuit of a flashgun.**

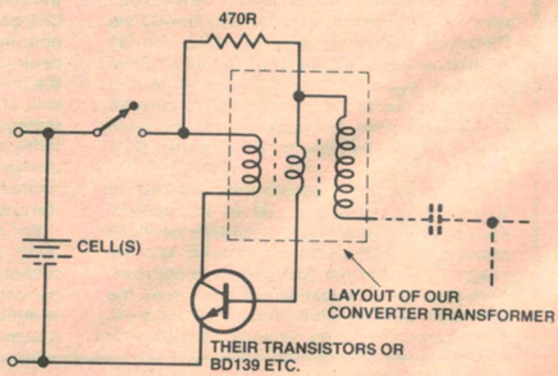
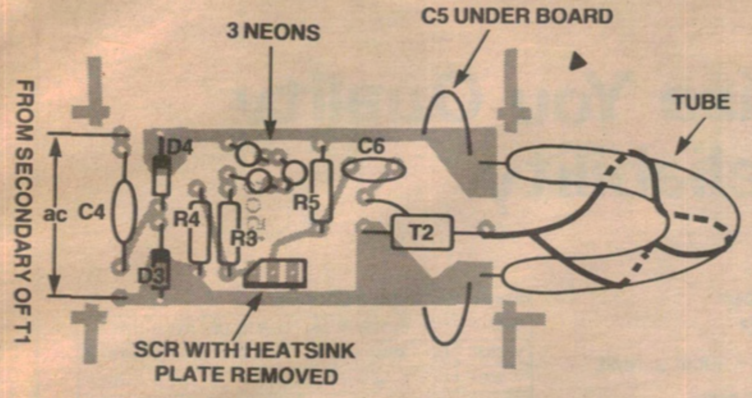
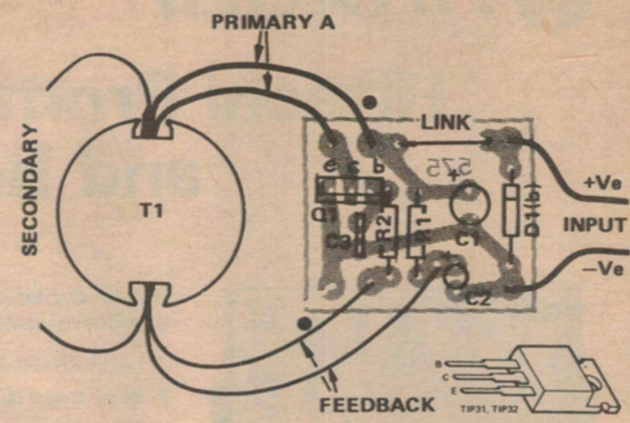


Figure 3. **Converter circuit from typical flashgun.**



1506 PCB OVERLAY — USING 3 NE2 NEONS



Construction

Construction is best commenced by winding the converter transformer, T1, if you're not using one from a cannibalised flashgun. Details are given in the accompanying panel. Having wound this, carefully scrape about 10 mm of the enamel from the end of each wire and tin carefully. Make sure you have the leads clearly identified.

The inverter board should now be assembled. This employs the ETI-575 pc board, and the accompanying component overlay shows the general construction and wiring. As usual, watch component orientation with D2, Q1, C1 and C2.

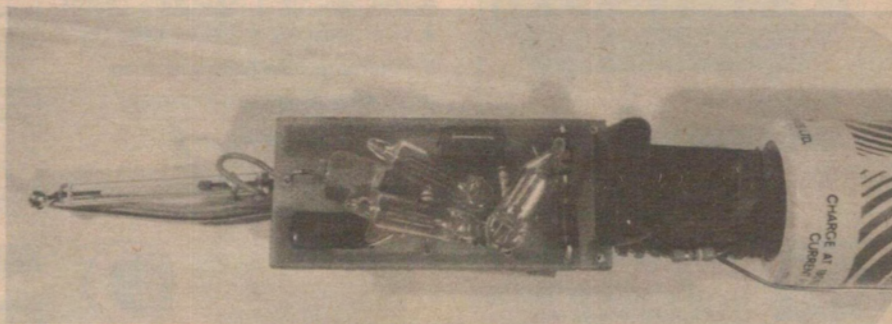
The flasher board can now be assembled. The component overlay shows general assembly for the U-shaped tube, but accompanying photographs show how a straight tube from a flashgun was mounted. Note that the discharge capacitor, C5, is mounted on the 'underside' of the pc board (i.e: copper side). Again watch the orientation of semiconductors. If you've gutted a flashgun, the single 220 V neon mounts between the free end of R3 and the track to the cathode of D4.

With the U-shaped flash tube, note that a length of tinned copper wire needs to be wrapped around the tube as a trigger electrode, and connected to the secondary of the trigger transformer, T2.

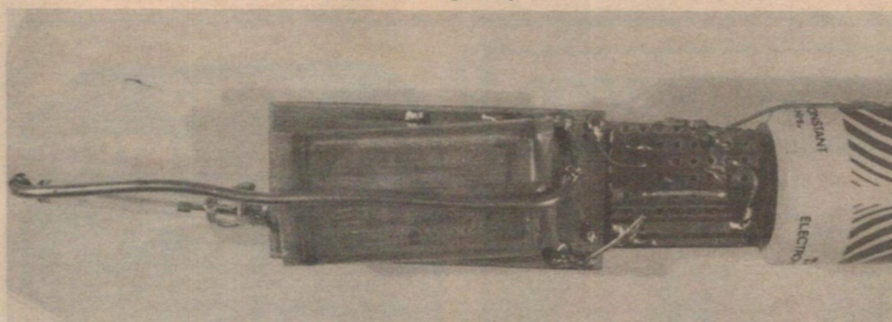
Once it's all together, apply power and see that it flashes as desired. If not, check the voltage across C5. If nothing there, reverse the feedback winding connections on T1 and it should work.

The housing is left up to you as individual requirements are likely to vary widely. If you want to mount the project in a perspex tube, the technique is described in the ETI-575 Light Wand article, ETI August 1979, p.55.

Happy flashing!



Close-up of Flasher construction from gutted flashgun, top side.



Same unit, bottom side.

PARTS LIST — ETI 1506

Resistors .... all ½W, 5%

- R1* 680R
- R2* 2R2
- R3 .... 120k
- R4 .... 82k
- R5 .... 1M

Capacitors

- C1* .... 20u tant.
- C2* .... 150n tant.
- C3* .... 10n greencap
- C4 .... 100n/250 V poly.
- C5 .... 1u5/250 V poly. This could be any value from 470n to 10u, at least 250 V or greater rating.
- C6 .... 22n/250 V poly.

Semiconductors

- D1, D2 .... 1N5404, A15P; 3 A diode. (1 A type may be used if slow charging only is used)
- D3, D4 .... 400 V (PIV), 1 A diodes — EM404 or sim.
- Q1 .... TIP31 or BD139, etc.
- SCR1 .... C106D1 or similar 400 V SCR

Miscellaneous

- T1* .... see winding details or text
- T2 .... trigger transformer for xenon flash tube** (e.g: Circuit Components TR4KN)
- NLP1 .... 220 V neon or 3 x 70 V NE2 type neons.
- B1 .... single Nicad battery
- SW1 .... SPST miniature toggle switch

Xenon flash tube** (e.g: Circuit Components type MFT1210); ETI-575 and ETI-1506 pc boards; clear case or tube to suit.

* Delete these components if using inverter components from flashgun.

** These components may come from scrapped flashgun.

Price estimate **$25-$28**