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Flash Gun Inverter Using Super E-Line Bipolar Transistors

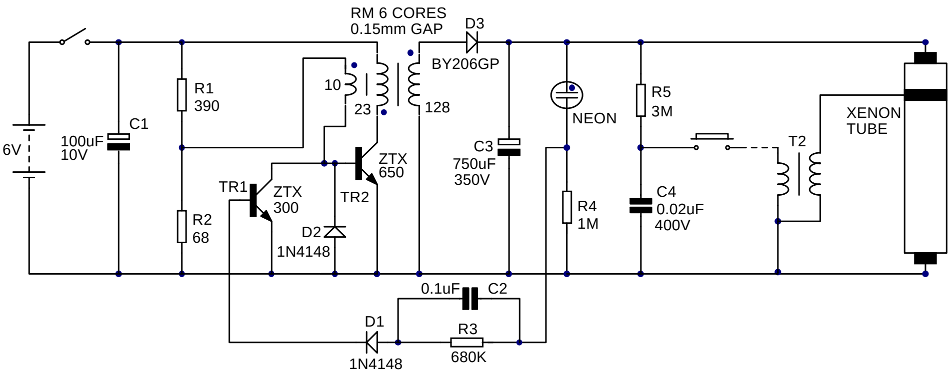

Figure 1.
Flashgun Circuit using Flyback Inverter.

The Xenon Flash tube considered for this design requires 250V to supply the flash energy of 20 Joules maximum, and about 4kV to ionise the gas to trigger it into conduction. The energy source available is a 6V battery. A flyback inverter is utilised to provide DC-AC inversion to charge the main reservoir capacitor. A suitable transistor for this circuit must possess a high enough voltage rating to withstand flyback transients, yet be capable of conducting sufficient current to pass a relatively large amounts of energy to the inductor. This combination of parameters would normally dictate that a large device would be necessary. However, the ZTX650 E-Line transistor - a 60V, 2A rated TO92 style product, allows an efficient, cost **and** size optimised design.

The operation of the circuit is as follows:

On switch-on, the transistor Tr2 is biased on by the resistors R1, R2 and a small voltage is generated across the primary of the transformer. The transformer action induces a voltage in the feedback winding which turns the transistor hard-on. Whilst the transistor is on, the energy is stored in the primary inductance of the transformer, and is delivered to the output circuit when the transistor turns off. That is, the stored magnetic energy is converted into electrical energy to charge the output capacitor. When the transistor is hard-on or saturated, practically the whole of the supply voltage is applied across the primary winding. Thus, linearly increasing collector current flows through the transistor, whilst the controlling base current I_B flows into the base. The transistor remains saturated until the collector current exceeds a value $\beta.I_B$ (β is the static common emitter current gain of the transistor). The transistor begins to come out of saturation and the collector voltage rises. The voltage across the primary thus decreases which also encourages a decrease in base current. This action continues until the voltages across the windings are reversed cutting off the transistor. The stored energy is now dumped into the output capacitor and secondary current decays to zero. For every cycle, an energy equal to $0.5Lp.Ipk^2$ is dumped into the capacitor (Lp - the primary inductance, Ipk - the peak current flowing in the primary prior to switching off).

With the component values shown in the diagram, the unit takes about 7 seconds to charge up fully, and will supply a flash energy of 20 joules.

When the trigger button is pressed, the capacitor C4 is discharged via the primary of the pulse transformer which generates a pulse of about 4000 volts on the secondary. This pulse is applied to the trigger electrode of the Xenon tube causing it to strike. The flash tube then discharges capacitor C3, giving a very intense flash of light. The intensity will depend on the value of C3 and the voltage to which it is charged.

To keep power consumption down, the circuit is designed so that when the output capacitor has charged up to the required voltage, the inverter switches itself off. The operation is as follows:

Initially, the voltage across C3 will be below the final value. The neon L1 will not be struck thus the voltage across R4 will be zero, Tr1 will not be conducting and the inverter operates normally. When the voltage across C3 reaches the final value, the neon L1 will strike causing a voltage drop across R4. This biases Tr1 on which keeps the transistor Tr2 off, thus inhibiting the inverter action. The charge on C3 then slowly decreases due to normal leakage and the small amount of current supplied to the neon and Tr1. When the voltage across C3 reduces to about 200 volts, the neon extinguishes, thereby turning Tr1 off and the inverter starts to re-charge C3.

The capacitor C2 is used as a speed-up capacitor. D1 and D2 protects the base-emitter junction of Tr1 and Tr2 respectively.