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Coil Gun Catastrophes and Triumphs

The building of this coil gun brought much sweat and tears. Many of nights have been spent trying to get this supposedly simple device working. Many prototypes have been gone through, but only one has triumphed. Even though this coil gun is not as powerful as the ones on YouTube, it holds a special place in my heart. In fact it has got the nickname "Soule Survivor". The spelling of soule is kind of like a pun. It is the only coil gun that worked, therefore it is sole. It is also soul, because it was a huge morale booster.

But enough of the silly ramblings, and onto the materials used in the gun. The coil is made of a pen with metal washers spread about 2 cm apart. The wire in the coil is 22 gauge enameled wire. The wire was wound around the pen 30 times in one direction. Then electrical tape was placed on top of the coil that was just wound. Next another layer of 30 wraps was wound going the opposite direction and tape was placed on top of this layer. Once completed the coil had 5 layers, which made about 150 wraps altogether.

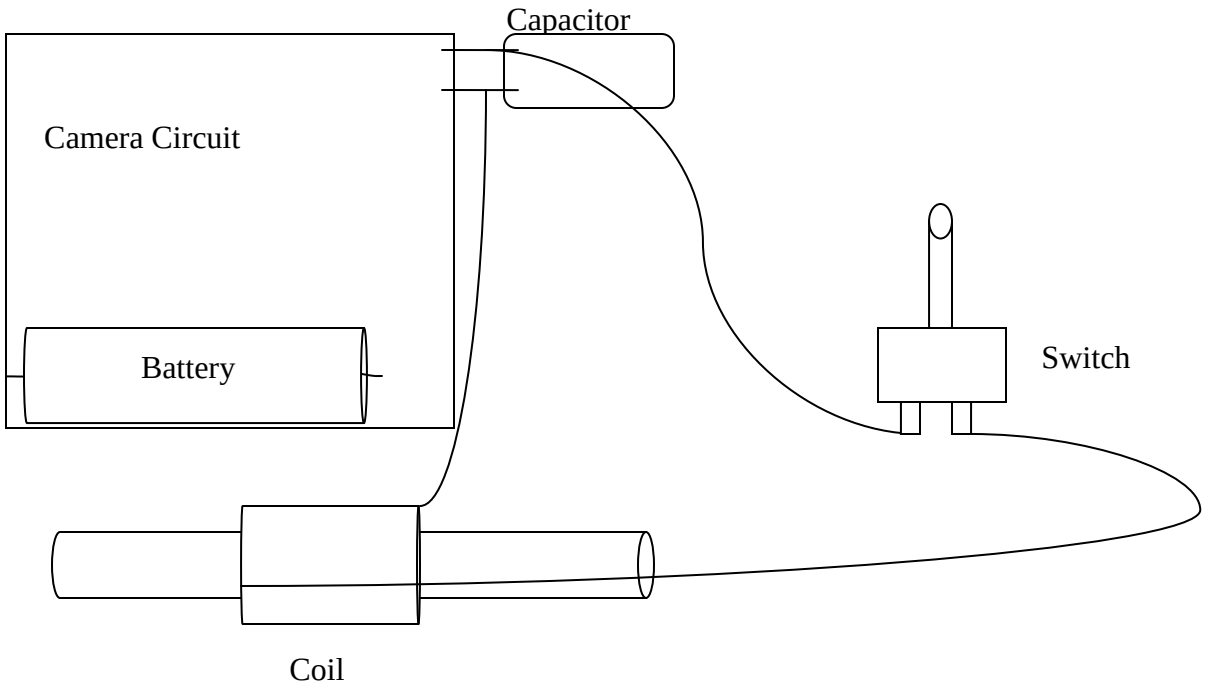
Now onto the circuit used in the device. The circuit was taken from an old disposable flash camera. It seems that these make perfect coil gun circuits. The circuit contains a AA battery that is wired up to the infamously powerful yet dangerous "capacitor". Throughout the building of this device there have been many close calls and even some mishaps. I have been shocked so many times by these circuits, that I believe that now am charged all the time. It seems like every time a door handle is touched, there is a spark. At first glance the circuit looked like the capacitor

was charged by just a single AA battery, but this didn't look right. After some inspection of the circuit, and some research, it was found the voltage from the battery went into a transformer that stepped the voltage up to around 300 volts. This large voltage quickly charges the capacitor up, which is usually used for the flash. This circuit is so much more efficient than something that could have been made by hand. It turns out that I am not the best solderer in the world, plus my knowledge of circuits is not very good. This circuit even includes a red LED that tells when the capacitor is charged, a win win situation. Instead of trying to desolder where the flash is at on the circuit, it seemed much easier to just solder the coil onto the leads of capacitor. The negative end of the capacitor is soldered to one end of the coil. The other lead of the capacitor is soldered to a switch that is rated up to 250 volts, but it worked out fine. The other end of coil is then soldered to the switch.

Now onto the actual physics involved in the coil gun. The basic principle in the coil gun is the magnetic field generated by the coil. The coil is in essence, a solenoid. This solenoid produces a quick and strong magnetic field that points the barrel of the coil. The field made by this solenoid is approximated by $B = NI\mu_0$,where N is the number of turns divided by the length of the coil and I is the current and μ_0 is a constant. The beauty of having a capacitor in this device is that it outputs a large current in a very fast time. This is what causes a strong magnetic field. This magnetic field produces a magnetic force $emf = -L\frac{dI}{dt}$. L is the inductance on the projectile, in this case a bb, that is caused by the magnetic field of the coil. The current is determined by the capacitor. The energy stored in a capacitor is determined by the formula $E = 1/2CV^2$, where C is the capacitance of the capacitor and V is the voltage that the capacitor is rated at. The capacitance of the capacitor used is said to be at 80 µF and is rated at 330 volts, which is very weak. But this was highest capacitance and simplest circuit that could be

found from the numerous disposable cameras that were bought. By the conservation of energy, potential energy equals kinetic energy, kinetic energy is given by $KE = 1/2mv^2$. Therefore the velocity could be calculated with the formula $= \sqrt{\frac{CV^2}{m}}$.

The performance of coil gun was not very good. It seems that coil guns are lucky to be at most 2 percent efficient. This is one reason the gun performed so lousy. Another reason that it was not as impressive was the amount of capacitance available. Ever since the spark caused by the first capacitor that was messed with, I have been very cautious of the amount of capacitance that I should use. This is why there was only capacitor rated at 80μF. But what "Soule Survivor" has achieved is good enough. It holds a special place in my heart.



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