

Tesla Coil

(*LOUDIN OSCILLATOR*)

The Oudin Oscillator is a high frequency current generator which uses the principles of electrical resonance to produce an antinode of high potential at the top of a large coil of wire. It is basically a high frequency Tesla transformer with the bottom end of the primary and secondary coils connected together and firmly grounded. The diagram below shows an Oudin coil that we have built for use at schools and public science shows.

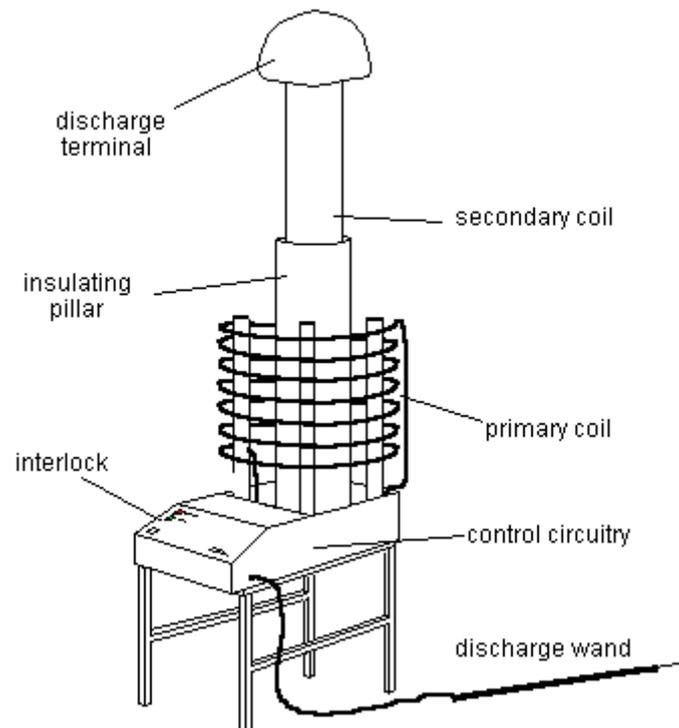


Illustration of a half-million Oudin Coil, designed and build at Glasgow University

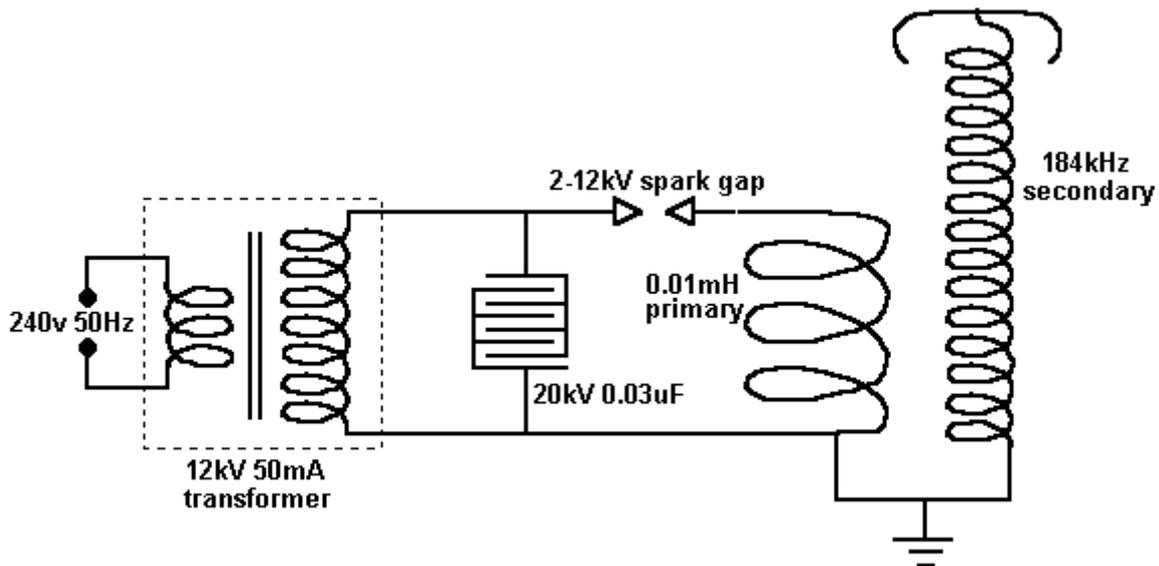
The primary coil contains seven turns of wire arranged into a large inductor which has about 0.01mH inductance. It is connected to a capacitor back via a spark gap. The capacitor bank has capacitance 0.03uF and is rated to a peak voltage of 20kV. The capacitor is charged directly from a 12kV transformer capable of delivering up to 50mA of current. When the potential across the capacitor reaches around 10kV the spark gap breaks down and the capacitor discharges violently through the inductor followed by a rapid ring down of the LC circuit formed between the capacitor and primary coil through the ionised spark gap.

The frequency of the current produced is 184kHz defined by the self-resonant frequency of the secondary coil (which matches the resonant frequency of the primary oscillations for maximum effective Q of the coupled system). The corona streamers are at peak potentials of around a million volts. As well as high frequency discharge (which is best demonstrated in the absence of any room light) there is a disruptive transient discharge caused by the 100Hz spark exciter at the base of the coil. This discharge is extremely powerful and should not be drawn off except by using a wand that is well fixed to the bottom of the secondary coil. The high frequency corona can be taken by the hand without discomfort although it is best to draw off the corona using a firmly held metal rod.

The diagram below shows the circuit of the high tension circuitry of the Oudin oscillator. The Tesla coil secondary contains 1500 turns of wire insulated to withstand 3kV between turns. The top 'mushroom' terminal can be replaced with a smaller spherical electrode to decrease the capacitance of the secondary and hence increase the Q of the secondary ring down, since this is given by

$$V_{secondary} = kQV_{primary}$$

where Q is the Q of the secondary coil and k is a constant which depends on the turns ratio and coupling between the primary and secondary coil.



Oudin Oscillator High Tension Connections

When over-riding the spark excited Tesla action and incorporating a high frequency signal generator, the impedance matching is of crucial importance. The Q of the secondary may be several hundred and so the on-resonance primary voltage need only be a few tens of volts to achieve several hundreds of thousands of volts at the top electrode of the Tesla coil secondary. Many hundreds of thousands of volts can be achieved with a few hundred volts on resonance in the primary which must then have a Q of hundreds to keep the power demands of the primary high frequency supply to a reasonable value, say a few hundred Watts. In a practical design it would be advisable to produce a 300v 184kHz 1kW signal source, which although not a trivial project, is the key to coupling enough power to the secondary. The impedance of the primary on resonance must be at least 100 ohms. This is achievable using a good 1kV polypropylene capacitor and good connections throughout the primary resonant circuit. Provided that the primary circuit is exactly on resonance with the Tesla coil secondary's self resonance with whatever choice of electrode is preferred, then the potential at the top electrode of the Tesla secondary will be kQ times 300v. For example, to obtain a megavolt of 184kHz energy at the top of the Tesla secondary, it is required to have $kQ = 3000$. If the turns ratio can be assumed to contribute a factor of only 10, then the Q of the secondary needs to be at least 300 which the supplied polythene secondary certainly satisfies.