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Little consideration has been given of recent date to the possibilities of high frequency excitation with emission spectrography. By such excitation it is possible to make spectrographic investigations for elements in non-conducting materials and to investigate organic compounds which have the property of luminescing.

High frequency excitation by means of a Tesla coil has been investigated in Europe but little in this country. Gerlach and Gerlach [1] tried incorporating a Tesla coil with an oscillating circuit fed from a transmitting valve, but shelved this arrangement because of undesirable features such as sensitive tuning, nitrogen bands and lack of high voltage. An open high voltage spark which possessed the bad features of noise and shielding was preferred to drive the Tesla coil.

The State University of Iowa has a General Electric Spectrosource Unit and a 2300 A.C. volt source supply. However, there was no source unit of high frequency design. High frequency spectrographic source units are apparently not available commercially. The immediate problem was to determine whether a Tesla coil could be driven by a vacuum tube oscillator and produce sufficient high frequency excitation for an emission spectrograph. A source unit based on this fundamental concept was constructed, which, it is hoped, will facilitate the investigation of materials which have hitherto been immune to emission spectrography.

The essential components of the source unit are a Tesla coil, vacuum tube, two variable air condensers, tubular resistor and a choke supplied from a 5 volt, 15 ampere filament transformer. (Figure 1)

The vacuum tube is a 304 TL triode transmitting tube, a type currently obtainable as a war surplus item for 75 cents (in contrast to their pre-war retail price of $50). The maximum plate voltage is 3000 volts, and the rated plate dissipation is 300 watts. The plate voltage is supplied by a 2300 volt A.C. source. The filament is supplied from a 5 volt, 15 ampere filament transformer.

The core of the Tesla coil is a glass cylinder 18 inches long with a diameter of 2½ inches. Insulated number 25 copper wire was used to wind the coil. The coil was wound with take-offs at 30 and 65 turns from the lower end and approximately 370 turns of wire

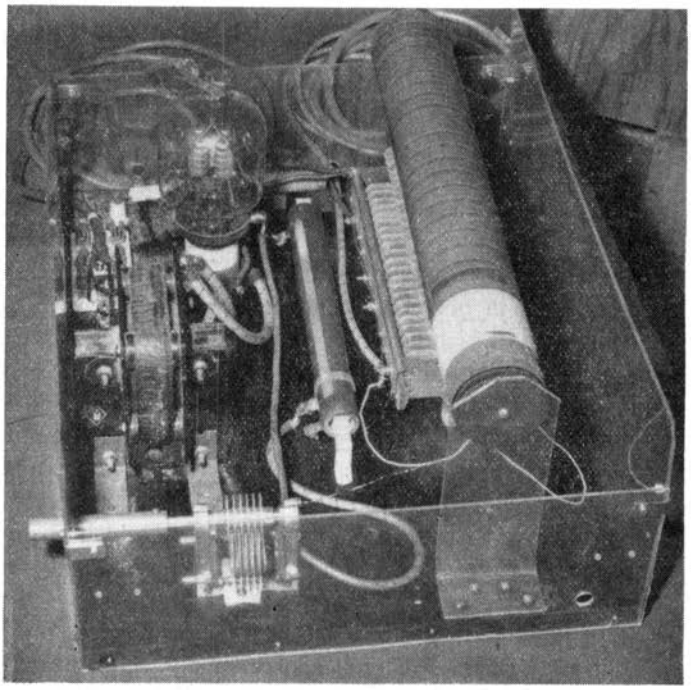


Figure 1. End View of Vacuum Tube Oscillator with Tesla Coil.

above the uppermost take-off. There are also take-offs at each end of the coil. It was observed that the electrode excitation was inversely proportional to the length of the cable between the electrode and the take-off end of the coil; consequently, this lead should be kept as short as possible.

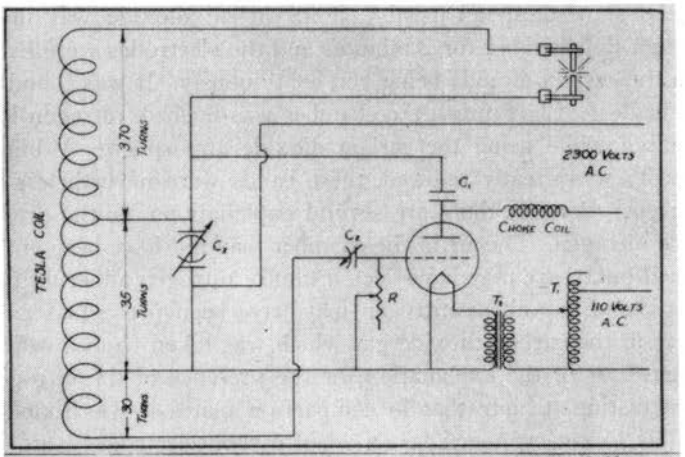
The Tesla coil and vacuum tube are incorporated in a conventional oscillator circuit with a variable grid condenser and a variable plate condenser (Figure 2).

The high frequency source unit can be readily used with ordinary electrodes and electrode holders, in which case it has been found that the excitation resembles that of other source units. The high frequency unit will give the same spectra as other source units provided allowance is made for nitrogen bands from the air.

Various electrodes and excitation cylinders were utilized to study the effect of the high frequency voltage. The unit was tested by means of solutions with high frequency electrodes patterned after the ones used by Gerlach and Gerlach.[1] The lower electrode consisted of a mica covered aluminum plate and the upper electrode a glass enclosed platinum wire as shown in Figure 3a.

One inch squares of a coarse cloth were cut and saturated with various 0.5 molar metallic solutions. The solutions used were stannous chloride, cupric sulfate, zinc nitrate, ferrous sulfate and aluminum nitrate. Each piece of saturated cloth was placed on the lower electrode and excited for 60 seconds. No burning or scorching of the small pieces of cloth took place and it was found that the principal lines of each metal in solution were present on the developed plate.

The bands present with high frequency excitation have generally been concluded to be due to nitrogen bands from the air. It was decided to check this theory by utilizing various atmospheres for the electrode excitation. Copper electrodes were used inside a glass chamber as shown in Figure 3b and a blank was run in air. The intense nitrogen bands which were degraded to the shorter wave



Circuit Diagram for Vacuum Tube Oscillator with Tesla Coil

V.T. - 304 TL triode tube, cathode 10 volts, 12½ amperes, max. plate voltage 3000 volts, max. freq. 40 Mc..

C_1 - Plasticon Glassmike condenser, .02 microfarad, 7500 W.V.D.C..

C_2 - Variable air grid condenser, 11 plates, 1/16" spacing.

C_3 - Cardwell variable air plate condenser, 45 plates, 4 sections, 5/32" spacing.

Choke coil - Radio frequency coil, 5 tapered sections.

R - Adjustable tubular resistor, 50,000 ohm, 150 watt.

T_1 - General Electric variable voltage autotransformer, 6 ampere, adjustable voltage output.

T_2 - Filament transformer, 5.0 volt, 15 ampere output.

Figure 2.

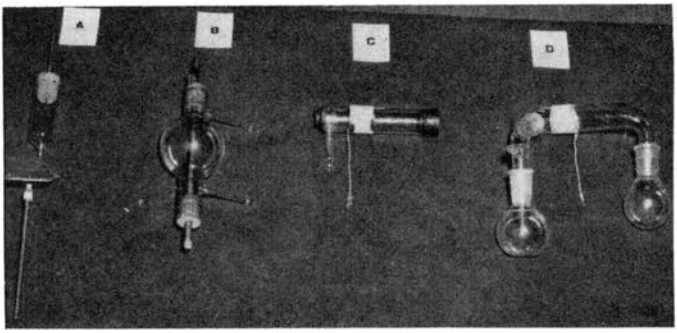


Figure 3. Electrodes and Excitation Cylinders.
A. High frequency electrode.
B. Glass chamber for various atmospheres.
C. Electrodeless glass cylinder.
D. Electrodeless glass cylinder with round bottom flasks.

lengths showed up as usual. Next, carbon dioxide was flushed through the chamber for 2 minutes and the electrodes were excited with the carbon dioxide being run continuously. It was found that irregardless of how much the chamber was flushed, nitrogen bands appeared while using the carbon dioxide atmosphere. While the intensity was greatly reduced, these bands were nevertheless very apparent. Perhaps there are several explanations for the presence of the nitrogen. The air in the chamber may not have been entirely flushed out, there may have been a film of nitrogen adhering to the glass chamber wall or nitrogen may have been present as an impurity in the carbon dioxide gas which was taken from a cylinder. Irregardless of the explanation for the presence of the nitrogen it is interesting to note that in comparison plates it was found impossible to get cyanogen bands when carbon electrodes were used with the Spectrosource arc and spark. The Tesla source unit brought out very distinctive nitrogen bands in the carbon dioxide atmosphere. This indicates the great sensitivity of the high frequency source unit and the possibility of its use in trace analysis.

A glass cylinder with a quartz window (Figure 3c) was utilized to test the unit for its ability to excite organic vapors. A small porcelain boat was filled with liquid benzene and sealed inside the glass cylinder. Luminescing would take place after the cylinder had been evacuated to 1 millimeter of mercury by means of a mercury manometer and a motor driven vacuum pump. After a number of runs with various types of photographic plates, the characteristic benezene bands described by McVicker, Marsh, and Stewart [2] were obtained. The wave lengths of the band heads were measured and

found to be 2666.2, 2678.2, 2739.8, 2752.0, and 2602.0 Angstroms. These corresponded to the wave lengths of the benzene band heads given in Pearse and Gaydon's "Molecular Spectra." [3]

Figure 3d shows a modification of this apparatus which utilized a continuous flow of benzene vapor and produced benzene bands of greater intensity.

In conclusion, a cheap, high frequency, portable vacuum tube oscillator incorporating a Tesla coil has been constructed. The nature of the excitation with metallic electrodes appears to be characteristic of the spark. One of the main objectives was to keep the oscillator simple and no doubt many modifications can be made. The primary purpose was to show that a Tesla coil could be driven by a vacuum tube oscillator instead of the customary open high voltage spark.

By a series of test runs the unit has shown its adaptability toward metallic electrodes, high frequency electrodes, and electrodeless discharge tubes.

Specifically, the high frequency unit may be utilized for the spectrographic investigation of organic compounds which possess the property of luminescing and for the investigation of non-conducting materials.

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