MDDC - 1107

UNITED STATES ATOMIC ENERGY COMMISSION

DESIGN OF THE HIGH FREQUENCY SPARK SOURCE FOR THE MASS SPECTROGRAPH

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Manuscript Date: June 17, 1946
Date Declassified: July 9, 1947

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Technical Information Division, Oak Ridge Operations
AEC, Oak Ridge, Tenn., 11-15-48--850-11401

Printed in U.S.A.
PRICE 5 CENTS

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It is the purpose of this paper to discuss the various improvements which have been made in the design of the high frequency spark ion source.

The circuit, which is quite simple, is shown in Figure 1.

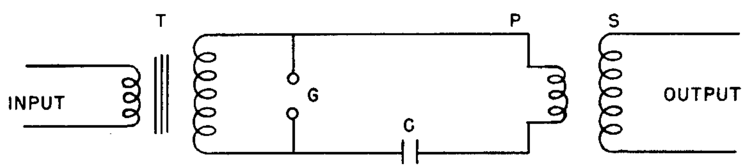

Figure 1. Electrical circuits of the frequency spark ion source.

The spark gap, G, breaks down 120 times per second when energized by 3000 to 5000 volts from transformer, T, whose primary voltage is adjusted by means of a variac. Each time G is closed by a spark, high frequency oscillations are set up in the tank circuit G, P, C in which the values of P and C have been adjusted for resonance. These high frequency oscillations are inductively coupled to a secondary, S, with a 40/1 turn ratio, and placed across the electrodes in the mass-spectrograph.

The early models of the spark circuit, built along the lines of the common laboratory demonstration tesla spark circuit, were capable of more power output than necessary and were thus bulky and somewhat inconvenient. The tesla coils, P and S, were 12 inches long with 5 and 8-inch diameters. Together with a plate glass condenser and the spark gap, these coils were immersed in a five-gallon earthenware jar filled with oil. The principal reason for the large geometry and oil immersion was the prevention of high voltage corona and breakdown. Since the spark output is connected to the accelerating voltage of from 10,000 to 30,000 volts, the insulation between P and S must be good. It has been found that adequate insulation is provided by concentric tubes of Lucite with a 1/4-inch wall. Use of Lucite tubing and No. 34 Heavy Formex wire in the secondary windings made possible a compact assembly 6 inches long and 2 3/4 inches in diameter.

This assembly consists of four concentric tubes 6 inches long.* The primary of 5 turns is wound in a groove of 5/16-inch pitch cut in a Lucite rod of 1 1/4-inch OD. This is covered by a blank insulating tube of 1 3/4-inches OD. Over this tube fits the secondary coil of 200 turns wound in a vee-groove cut 48 threads per inch on a tube of 2 1/4-inch OD, covered by another tube of 2 3/4-inch OD. The grooves for the secondary windings are cut on a 2 1/16-inch diameter to allow space for a thick coat of Dow Wax over these windings. The precautions of equal spacing with Lucite thread wall separations, of wax coating, and of heavy formex insulation on the wire have effectively prevented sparking

* The extruded tubes provided by the manufacturer had to be machined to provide a slip fit.

between the various turns of the secondary winding, a difficulty encountered before these precautions were observed.

The problem of making a positive connection to the secondary windings was solved by the use of split rings fastened to the Lucite tube at the two ends of the windings. The wire was soldered to these rings which were tapped to fit binding posts screwed in through clearance holes in the outside cover. Threading the Lucite was found unsatisfactory. The primary leads pass through holes drilled on the axis of the Lucite core.

A condenser of fairly small physical dimensions was found to be satisfactory, 2 by 2 1/2 by 3 3/4 inch mica capacitors (Cornell Dubilier Type 86 or Aeroxex Type 1995). The value of the capacity varies with the other circuit constants in the resonant circuit; we are now using .004μf.

The spark gap used most has been a hydrogen filled (atmospheric pressure) gap consisting of two 2 mm tungsten electrodes sealed into a Pyrex cylinder with about a 1/4-inch gap between them (see Figure 2). Experiments have been made with an air gap between tungsten disks. One such gap,

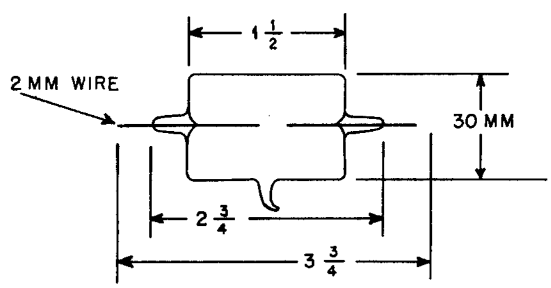

Figure 2. Spark gap in detail.

shown in CP-2410, Figure 8, consisted of 1/4-inch diameter tungsten disks mounted on larger copper disks with fins for heat radiation. Gap separation was provided by mica washers. This operated quite satisfactorily; however, sputtering from the spark gradually deposited a conducting coat on the mica surfaces causing a short circuit. This could be corrected by disassembling and scraping the mica. The hydrogen gap short circuits less often because of the larger glass surface and can be cleaned quickly by shaking up the carborundum which is sealed in the tube for this purpose. This gap is mounted in a small oil bath for cooling.

A compact unit consisting of Lucite tesla coils, spark gap, and condenser was shown in CP-2410, Figure 8. Later, this assembly was adapted to the oil-cooled hydrogen gap and built around the oil tank as shown schematically in Figure 3.

A neon sign type transformer with a 5000 volt current limited (30 ma) secondary was found sufficient to energize the spark circuit.

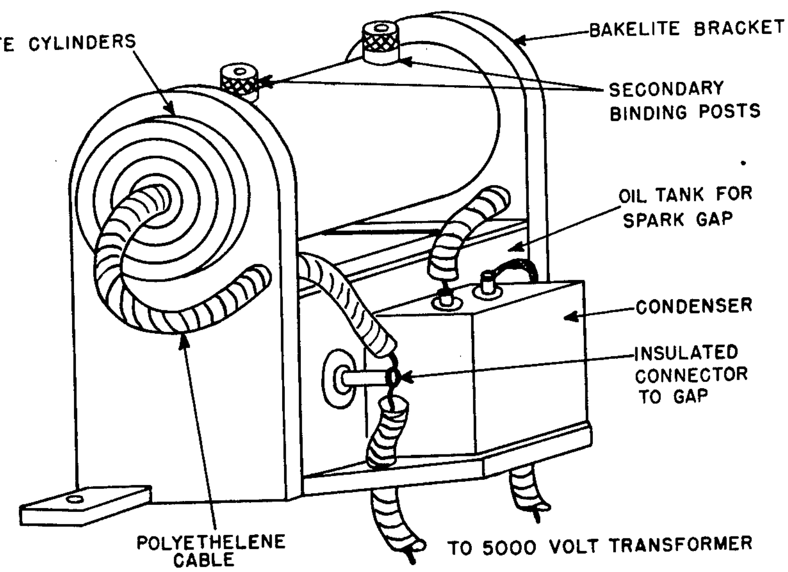

Figure 3. Complete assembly of the high frequency spark ion source.

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