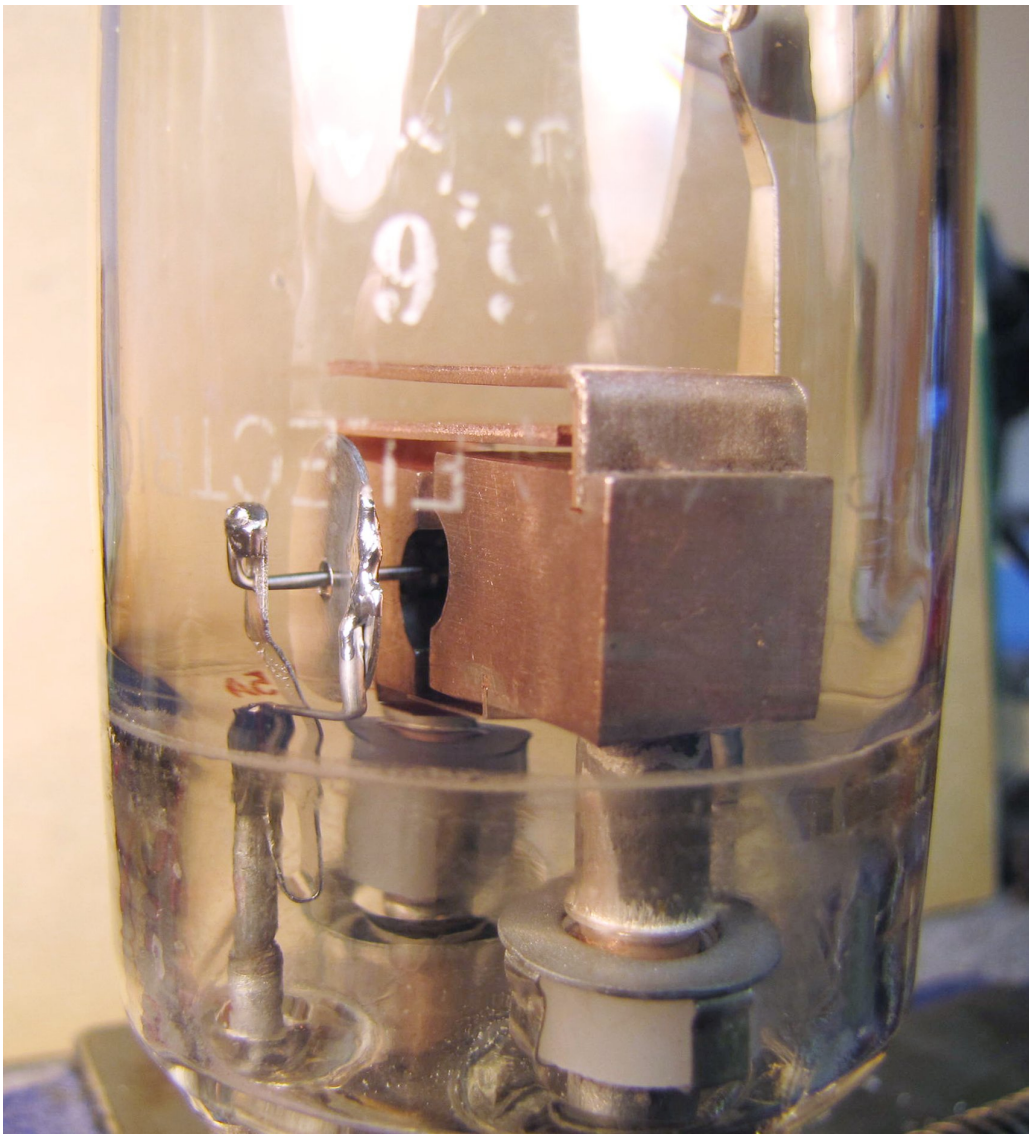
Early Magnetrons at CHRS -- on the way to Radar

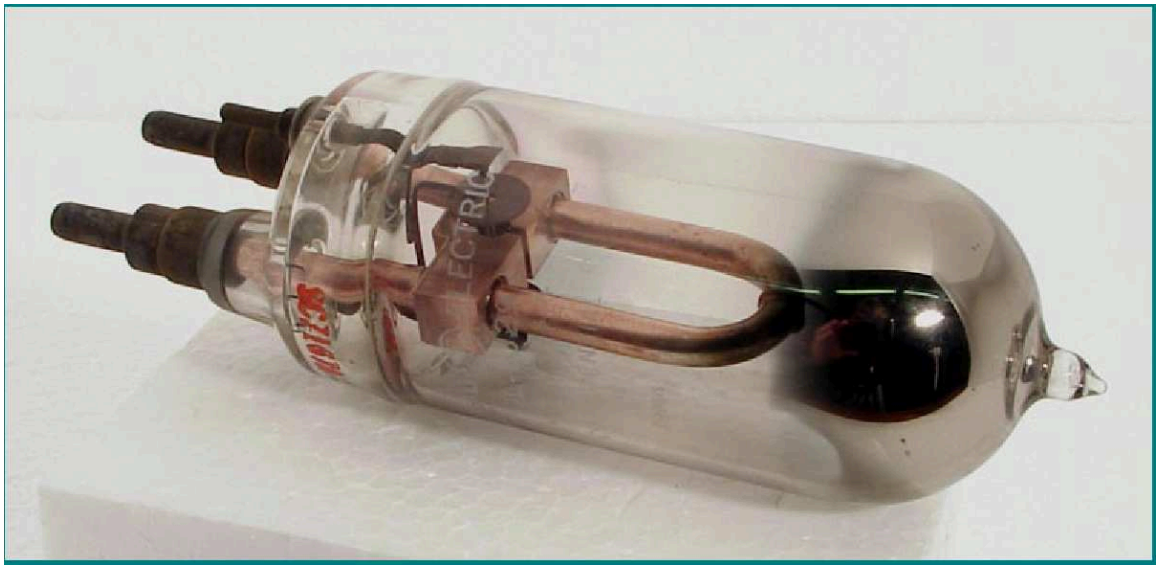
A Note by Bart Lee, K6VK, CHRS fellow, AWA Fellow

John Staples discovered a pretty odd vacuum tube recently (Fig 1 -- 1930s ?), and Kent Leech has now donated a couple of them to CHRS. They are early split anode magnetrons. Magnetrons used an external magnetic field to affect the electrons emitted from the filament so they could create ultra high frequency oscillations.



1

British National Valve Museum says of Fig. 2: “The [UK General Electric] GL5J29 is a two anode magnetron. The filament is visible as a rod passing through the circular hole formed by the two anodes. An output tuned circuit would be connected to the anodes with the DC power fed into a centre tap. The wide glass tube envelope is 47 mm in diameter and, excluding the base pins, is 150 mm tall. The base is a four pin special, with two large pins and two small pins.”



2

One way to think about magnetrons is that the magnetic field keeps a cylinder of electrons, coming from the filament, rotating around the filament but inside the anode(s). The positive polarity of the anodes pulls the electrons away from the filament and towards the anodes. The magnetic field in effect repels the rotating cylinder of electrons from the anodes. There obtains the same sort of orbital balance as a moon around a planet: acceleration of gravity vs. acceleration (velocity in a circle) of mass, but in this case the "moon" is a cylinder and the gravity is negative (repulsive) from the outside balanced by the electrical field pull of the anode(s).

John says: “Imagine that an RF field already exists between the elements of the anode (2 or some even number). The RF field will have an additional effect on the electron orbits. Remember that the orbit radius is related to the electron velocity from the cathode, which is related to the voltage (energy of the electrons) between the cathode and the anode. During part of the RF cycle, some electrons will be able to hit the anode and sustain the RF oscillation (positive feedback).”

John’s device needs an external tuned circuit between the anodes but the GL5J29 version includes that inside the envelope. These are pre WW II experimental devices. The British created working multiple cavity magnetrons about 1940. These made effective high power UHF and airborne Radar possible.

John suggests an explanatory animation: www. radartutorial. eu/ 08. transmitters/ Magnetron. en. Html .

According to the Wiki, there are about one billion magnetrons in use today, in microwave ovens. https:// en. wikipedia. org/ wiki/ Cavity_magnetron presents an excellent history.

(de K6VK, thanks to John Staples) ##