10AL1 - S-Band Experimental Klystron

- **Click to enlarge**

The above sample has no ink markings but the inscription 10AL1 hand engraved on the base with a sharp tip. At a first glance its shape could resemble the WE 707A, even the same size. Carefully looking at its internal construction, some differences can be appreciated. The two copper discs, clamped outside to the external resonator, terminate internally in two gridded flat surfaces, as in the image below. The reflector is a flat dish, probably made of nickel.

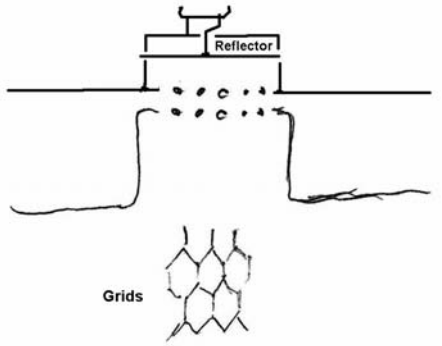


Fig. 1 - Approximate sketch of the disc seal grids and of the resonator, as they can be observed from outside.

The exact story of this device is now lost. Nevertheless we can try to understand the purpose of this prototype and approximately date it.

Early British klystron oscillators, based upon the 1940 Sutton design, as the Canadian REL 8, or the improved variants CV35 and CV67, required high resonator voltage to operate, in the order of 1700 volts. Such high voltages originated ionization phenomena, making difficult their use in airborne radar sets. Conversely the more recent design of the 707A, by Western Electric, operated at only 300 V. In the image below we see the internal structure of 723A and of an equivalent British NR89 ‘Sutton’ oscillator.

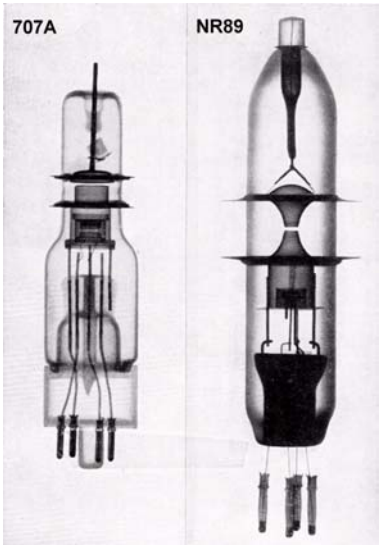


Fig. 2 - In this image we see on the left the X-ray section of a WE 707A near the section of an early British design. Note the similarities of the 707A, in particular the re-entrant shape of the lower copper disc intended to minimize stray capacitance in the resonating circuit, with the sketch of fig. 1. Click to enlarge.

According to Callick, in late 1941 TRE asked for a British S-band design capable of operating below 300 volts, at the same voltage of the receiver IF strip. The above requirement led to the development, starting from the WE design and under the assistance of the Signal School in Bristol, of oscillators characterized by close electrode spacing, large and flat cathode surface and flat reflector dish. Such a design granted a beam with electrons following short parallel trajectories. As result bunching of electrons at low voltage could be more effective. Due to the large inside diameter of the resonator discs, about 10 millimeters, coupling of resonators with the beam was increased by grids made of thin corrugated tape, 1 mm wide, folded and brazed to inner rim of copper discs. Tape was preferred to wires, as used in 707A, in order to improve coupling and at the same time minimize both capacitances and cross section of grids.

In the left image below we can catch a glimpse of the grids in our sample. Above the resonator top grid, at about 6 mm drift space, we see the flat reflector dish. In the right photo we see the ribbon grids of a CV237, one of the frequency variants of the final KR6 design, approved by May 1943 to replace old high voltage types.

In the CV237 the grid mesh looks less dense and randomly bent, but we do not have a clear image of the meshes in the 10AL1 sample. Anyway minor differences between arrangements of meshes in the two samples can well be explained considering the quite long developmental work, about ten months, described by Callick. The drift space is quite the same, the reflector in the CV237 being almost in the same plane of the rim in the resonator disc.

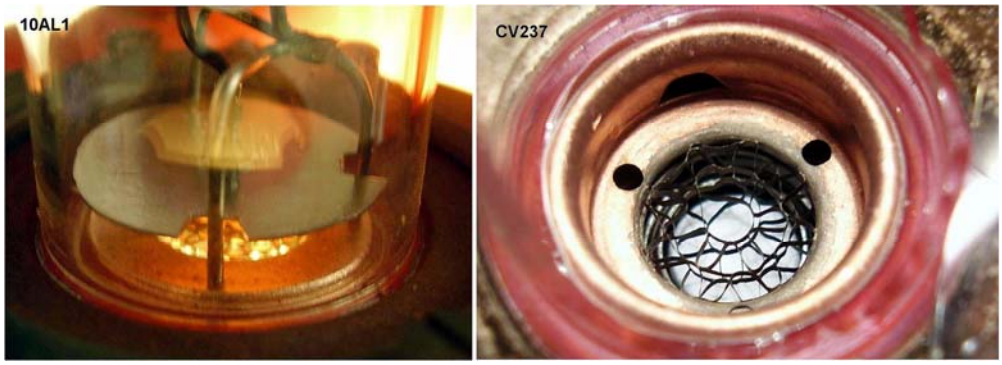
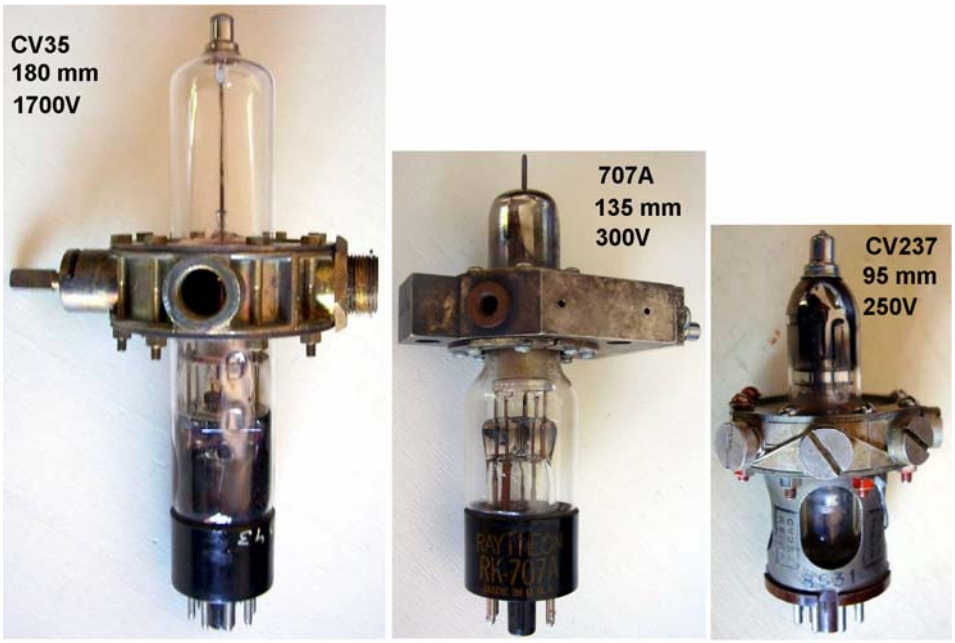


Fig. 3 - Left, a glimpse of the grid meshes in the resonator inner hole of the 10AL1. Right, the ribbon meshes brazed to the inner holes of the resonator discs in a CV237 S-band low-voltage klystron.

We could then assume that the 10AL1 is a prototype probably built by EMI around the mid 1942, during the early developmental steps of a new family of low-voltage S-band klystron oscillators inspired by the novel design of the WE 707A. Eventually this activity led to the KR6 design with its frequency variants, as the CV237 or the CV238. The refined design of the KR6 family, with 100 mW typical output power at only 250 volts resonator voltage in a considerably compact size, made it possible to outperform the WE design.



- The evolution of British S-band klystron oscillators. CV35 was a typical klystron of the early generation designed in 1940. 707A, in the middle, was introduced in 1941 by Western Electric. CV237 on the right can be considered the British version of 707A. 10AL1 was an important step of such evolution.

References:

- **Metres to microwaves, Callick**
- **Klystrons and microwave triodes, Hamilton et al,**
- **Direct observations on samples of the ase-museoedelpro collection**

Last edited July 2020 by Emilio Ciardiello