E.1189 8-Cavity Magnetron Prototype, July 1940

Click to enlarge

This specimen is, to the best of our knowledge, the very first prototype of the E1189 eight-cavity magnetron design. Probably it started oscillating in the GEC laboratories within the end of July 1940, while the E1189 No.12, the one brought to America by the Tizard Mission, was in progress to be assembled.

It has small characters punched on the copper cylinder, 1189 C 328. No doubt that the first four digits stay for the design code E1189. This was the GEC internal code for the first 10 cm multi-cavity magnetron, appeared in the mid 1940. 'C' could indicate the third revision, assuming that 'A' was the six-cavity design No.1, the one with filamentary cathode, and 'B' was the E1189 No.2, the six-cavity one with oxide-coated unipotential cathode. In the last group of digits, '32' could indicate the anode height and '8' could refer to the number of cavities. Dimensions of the body and of every details, as holes, slots and cathode, are all compatible with those given by Megaw for the eight-segment E1189 itself **(*7)**.

E.1189. (a) 6 - segment type, now replaced by (b).(opt.H = 1400 g.)

(d_a = 12.0, d_c = 12.0, l_a = 20, s.w. = 2.0, s.d. = 2.0, d_k = 4.5; λ = 9.8 cm.) *

15 valves made including experimental variants (see below).
Life data: 1 emission failure 225 hours (poor emitter initially).
3 between 50 and 100 hours. (2 had poor contacts in heaters initially, were repaired as soon as replacements became available and are now in service again; the third was accidentally broken; none showed any deterioration in performance). The remainder have been run for periods between 5 and 30 hours; all OK except 1 heater failure at 30 hours.

(b) 8 - segment type.(opt.H = 1050 g.)

(d_a = 16.0, d_c = 10.0, l_a = 20, s.w. = 1.6, s.d. = 3.3, d_k = 6.0; λ = 10.0 cm.)

4 valves made: 3 O.K. at 20, 30 and 60 hours respectively,
1 heater open-circuited at 210 hours.

The anode block looks made of bare copper, no radiating fins were brazed to its outer wall. It is a cylinder measuring 50 mm diameter by 32 mm overall height. A partially erased hand inscription containing characters '??75/HR210' is still visible on the body, near to the heater spacers. The block has eight hole-and-slot resonating cavities all around its axis. Other measures are similar to those given for the E.1189 eight-cavity type: 20 mm anode useful length, 16 mm anode internal

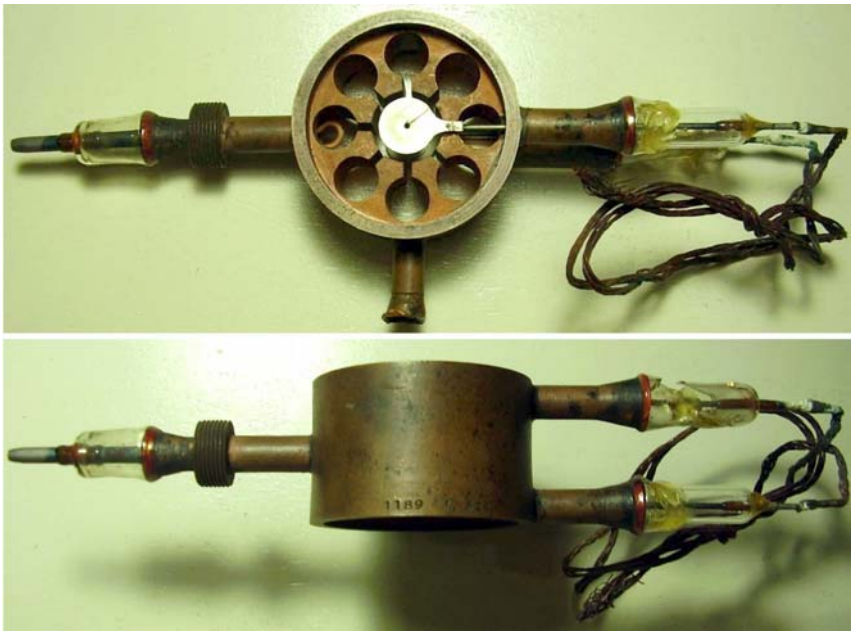
diameter, 1.6 mm slot width, 3.3 mm slot aperture. Inside one of the two end spaces, the wall around the cathode rod still shows traces of a clear and sticky substance, probably sealing grease.

A large center hole accommodates the 10 mm diameter oxide-coated cathode assembly, held by two rods going to the outside through a couple of glass stems and welded to the flexible heater-cathode stranded wires. The heater helix ends terminate to a couple of baffles, welded to the heater rods. The baffle corresponding to the common heater/cathode connection is spot welded to the flanged cathode cylinder. The oxide layer appears uniform over about two-third of the surface. A relevant thinning of the oxide can be observed near the two ends of the cathode cylinder, leaving the nickel exposed in a couple of zones. Near to the cathode floating end, the oxide layer is visibly swollen and even detached in a small zone.

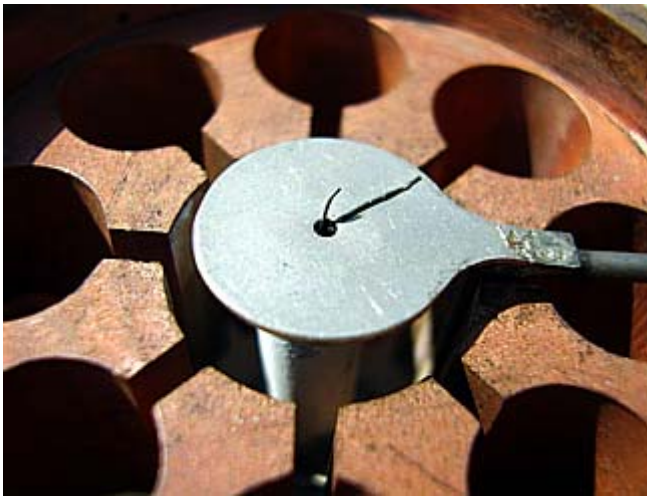
A small copper tube, about 20 mm long and flared to the external edge, is brazed on the outside of anode block, halfway between its ends and orthogonally to the cathode/heater supporting rods. The tube shape recalls that of the heater spacers. Almost certainly a glass stem was sealed to it. Probably it was intended to evacuate the anode chamber while continuously pumping and at the same time making it possible to observe the cathode temperature by pyrometric techniques.

By no way this sample can be confused with the quite common display units obtained removing the end caps from standard magnetrons, to show their internal construction. None of the known magnetrons looks like this one. The code punched on the copper block, the absence of both the end covers and of any radiator and especially the presence of the side copper tube suggest that this sample was a very early developmental prototype of the GEC eight-cavity E.1189 magnetron design. The cathode/heater subassembly is complete and the oxide layer shows clear signs of rough operations, even beyond safe limits. The bubble in the oxide might indicate local arcing. Traces of clear sealing wax reinforce the possibility that it was used in a test rig while continuously pumped, almost certainly closed by movable end plates, into the pole pieces of a permanent magnet.

For sure this prototype was built to be powered and actually it was, to the point of damaging the oxide layer on the cathode. No need for the complete cathode subassembly, including oxide, heater and end baffles, if it was intended as a nice paperweight. Its manufacture looks too accurate to believe that it could be built in handicraft laboratory, such as that of the Birmingham University could be. Everything leads us to assume that it was built at GEC for internal test purpose.



Two more views of the sample, with the code punched on the outside of the anode block. Click to enlarge

- Left, the barely visible handwriting on the anode block, containing the characters '/HR210'. Not sure but the first part of the writing might contain '75', indicating that the tube was operated for 75 hours before the endurance test. Right, the heater wire is broken at the welding to the floating end baffle, opposite to the one welded to the cathode cylinder. Click on each image to enlarge.

- Two views of the cathode surface. The oxide layer is uniform and in good shape for about four-fifths of the cathode cylinder. Near one of the ends the layer is quite thin somewhere, leaving exposed the underlying metal. Oxide also looks swollen and detached in the small area evidenced in the image at right. One side of the cylinder ends in a flange, spot welded to the one end baffle. Not sure, but metal looks to be nickel. Click to enlarge.

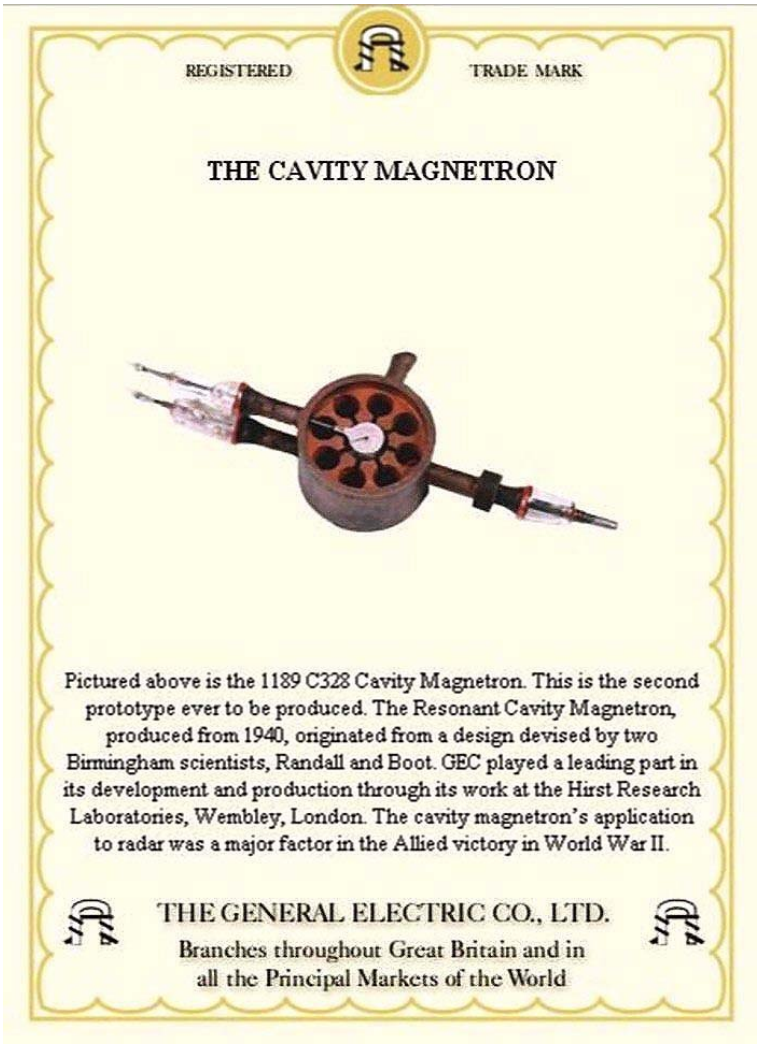
- Detailed view of the internal hole corresponding to the side copper tube. It is round and exactly in the middle of the resonator. By the way, looking from outside through the copper tube, the visible cathode surface appears in a good shape. Unfortunately in the second image the oxide surface is out of focus and just its uniform whitish look can be appreciated. On the right, the hole hosting the output coupling loop looks to have the same diameter. Click to enlarge.

Dating of the sample

From April, GEC began to work side by side with Birmingham at the development of the cavity magnetron just devised. We know from the paper 'The Cavity Magnetron' by Boot and Randall (*13) that several steps of development were already planned at the date. We have the full list of developmental cavity magnetrons with different resonator systems built at GEC up to the date of 11 October 1940 in a **Megaw's secret report** **(*7)**. Megaw lists four units made of eight-segment, 1.050 gauss E1189. We know from the 1946 Megaw's notes **(*8)** that two of these units were serialized as No.12 - the one brought to America by Bowen - and No.13, used by Megaw himself to characterize the new device. The four units operated for different numbers of hours: this leads us to assume that they were put into operation as soon as they were ready and then that they were all turned off at the same time. Only one of them, the first one to be operated, was later put back into operation for the endurance test, until the heater became open-circuited. The main development steps of the eight-cavity magnetron are also fixed by another source, the wartime diary of Sir Clifford Paterson, Director of the GEC Research Laboratories at Wembley.

Almost certainly our sample is the fourth E.1189 type b, listed by Megaw, the one totalizing 210 hours until heater opened. Few doubts that it was built and first operated while still assembling the sample eventually given to Bowen. It was first used to perform functional tests on the new eight-cavity design and after August 7 it was used to perform an endurance test.

To confirm the above reconstruction, here is the page visible in the old GEC Archives, which represents the second Prototype 1189 C 328 of eight-cavity magnetron ever built.

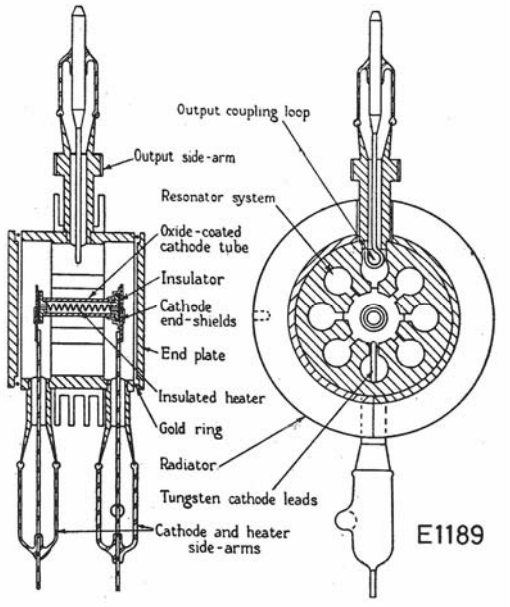


Here is the summary of its main features:

- **The design and the same dimensions of electrodes are identical to those of the final release of E.1189.**
- **It is complete with an oxide-coated cathode subassembly which shows clear traces of operation. The heater wire is broken at one end. Traces of vacuum grease are still visible inside the copper block, near to one of the edges.**
- **The absence of the external finned radiator, the presence of a copper short tube and the lack of end caps clearly indicate that it was an experimental unit, made for internal laboratory tests at GEC and operated while continuously pumped.**
- **On the copper anode block a punched code starts with the characters '1189', followed by C 328. 'C' could stay for the revision level of E.1189, after the six-slot filamentary cathode and the six-slot oxide-coated cathode designs.**
- **On the same block, handwritten with a marker, '??75/HR210' characters can be read, that could be the running hours at 6 August and the total life of the fourth sample listed by Megaw. 75 could stay for the hours worked until 6 August.**
- **The source of this sample was the same of several other historical tubes, related to the developments of British radar. Possibly coming from a British Marconi warehouse.**
- **The No.2 prototype advertised in this page by GEC looks identical.**

No doubt then that this E.1189 prototype is the very early eight-cavity magnetron sample operated at GEC in performance tests. Probably it started oscillating since the end of July, while the sample No. 12 - the one brought to America by the Tizard Mission - was still in progress of being assembled. Later, after the approval of the eight-cavity design review on 6 August, it was used to run an endurance test, until heater opened after 210 hours of operation.

The reconstruction of the eight-cavity magnetron development at GEC can be read at this link.



Final draft of E.1189 magnetron approved as NT89 (A.P. W.2510) or REL 3D. The finned radiator is simpler than the one in the No.12 sample, with four fins instead of eight. Click to enlarge.

Acknowledgements

My thanks go to the many people which supplied information useful to reconstruct the development of multi-cavity magnetron at Birmingham and at G.E.C. A special thanks goes to Mr. Yves Blanchard who sent this **kind mail** with his authoritative opinion and some documents that I added to the references below.

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Last edited on June 2, 2020 by Emilio Ciardiello