Dear Mr. Ciardiello,

Thank you for letting me know this very beautiful piece of your collection. It is indeed quite exceptional. I apologize for my late answer, but I wished to take time for studying your explanations in detail, and to see if I could find some new materials in my own documentation.

You know that this "invention of magnetron" question is very complicated, and still today a bit controversial, in spite of a very rich bibliography, and (at least) three conferences devoted to the subject : the *"Seminar IEE on the History of Radar Development to 1945"* in London on 10th-12th June 1985 ; a *"One day symposium : Fifty years of the Cavity Magnetron "* on 21st February 1990 at the University of Birmingham ; and the most recent one, *"CAVMAG 2010, International Conference on the Origins and Evolution of the Cavity Magnetron"*, at Bournemouth on 19th-20th April 2010. I had the chance to attend this last conference, and to meet some specialists who probably could enlighten you. I suggest three people, with their links (joining also two souvenir photos of our meeting). Even if I did not keep in touch with them since this time, you can try to contact them on my behalf, with reference to our meeting in Bournemouth :

Phil JUDKINS, Defence Electronics History Society DEHS, philjudkins@btinternet.com
Rod BURMAN, a famous collector that you certainly know , rod.burman@btopenworld.com
Alain REDDISH, retired from GEC, areddish01@aol.com

I have also scanned some copies of papers which could be added to those you have quoted in your note. Due to their size, I will send them to you later by "We Transfer" :

[1] - M.J. LAZARUS - "Electromagnetic radiation : Megahertz to Gigahertz. A tribute to Heinrich Hertz and John Turton Randall"
Proceedings IEE, Vol. 133, part A, n°2 (march 1986), pp. 109-118
[2] - W.E. WILLSHAW – « GEC's Wartime contribution », in "Fifty years of the Cavity Magnetron", Proceedings of a " One-day symposium " (21 february 1990), pp. 61-70, ed. by P.M. Rolph, The School of Physics and Space Research, University of Birmingham (1991)
[3] - W.E. WILLSHAW – « Microwave magnetrons : a brief history of research and development », *GEC Journal of Research*, vol.3 (1985), pp. 84-91
[4] - J.B. FISK, H.D. HAGSTRUM, P.L. HARTMANN - "The Magnetron as a generator of centimeter waves"
The Bell Sytem. Technical Journal, vol. 25 n°2 (april 1946), pp. 167-348
[5] - H.A.H. BOOT et J.T. RANDALL - " The cavity magnetron "
Journal of IEE, vol 93, part III A, n° 5 (1946), pp. 928-938

Unfortunately, after a new reading of these papers, I could not find a definitive answer to the question you are asking. So, here is only how I see the matter.

On the first hand, two facts seem perfectly clear, and may be taken as a starting point:

- The presence of an oxide cathode reveals that your copy is later than June 29, 1940 (the day of the first test of E-1189 1b 1kW peak, [3] p.86)

- The absence of the usual finned radiator, and the intrigating copper tube on the side of the anode block show clearly that this is a laboratory prototype, used to study and understand some particular aspects of the magnetron operating

From this starting point, it seems to me that 3 hypotheses can be put forward, to take into account the eight cavities structure :

Hypothesis 1- It is the one that you put forward, and it is undoubtedly the most likely : your tube would be one of the prototypes built by Megaw at GEC, between July 10, 1940 (end of the first E-1189-1b tests) and early September 1940 (Bowen's departure for Canada). These prototypes could have been built to reduce the magnetic field required by shortening the gap of the magnet, increasing the diameter of the cathode, and changing from six to eight cavities. The initial Megaw's E-1188 had a 4 cm high anode, put into an electromagnet gap of 5 inches (13 cm) ; in the E-1189 these dimensions were reduced to 2 cm high for a 3, 8 cm gap and cathode diameter 0.45 cm. Your specimen has an anode height of 2 cm and a cathode diameter of 1 cm (I think). It is worth to note that its probes (for the cathode supply and the output of the HF oscillation) both look very similar to those of the GEC final copy (the standardized E-1189 / NT98 for naval use, and E-1198 / CV38 for the first centimetric AI airborne inteceptor).

So your tube could be one of the E-1189 prototypes numbered 2 to 11 (the 12 being in a Canadian museum I think).

But most probably, it could be a simplified model (without fins), built by Megaw to make preliminary tests on the conditions of passage from 6 to 8 cavities before manufacturing a definitive 8-cavity version ?

You are right when you point out that there is a doubt about Bowen's assertion saying that E-1189 No.12 was the first to be made with 8 cavities. In [2] p. 70, WILLSHAW qualify it as a "story telling ", introducing an interesting discussion with R. BURMAN :

Mr Burman : Actually the question I wanted to ask Mr Willshaw relates to the production of the first eight-cavity magnetron as opposed to the six-cavity version. Your description and your explanation of it that it was required to improve the efficiency within the available magnet, ties up with Megaw's paper presented in 1946. If you read Dr Bowen's Radar Days, he has a rather more story-telling type of version. He describes how he turned up at the Bell Telephone Laboratories with the magnetron and they X-rayed it and found that the one that he had had eight cavities and when he rang up Megaw to find out what had happened, he was told : "oh, my goodness, yes, I asked the foreman to make ten anode blocks with six cavities and one with seven and one with eight and the one with seven was, the one that didn't work". Is that really the case? or it that just a bit of historical nonsense?

Mr Willshaw: Yes I think that is just another bit of historical mis-management. There is no point in going to odd numbers of cavities in view of Megaw4s earlier experience, although, undoubtedly, the seven-cavity one would have worked quite well but with all the mode-change problems of it, presumably"

But I did not find in my papers any reference to those *"four samples made of the E-1189 b and all used in life tests according to Megaw's report dated October 11, 1940"*, that you mention in your note : I suppose that you found them in "E. Megaw - Notes on magnetron development program"? I do not know this paper, and I would be very pleased if you could provide me with a copy

Hypothesis 2 - anyway, I think that a second possibility may be evaluated : your sample could have been built after september 1940 at the University of Birmingham. It is known that after the industrialization of the E-1189 / NT98 by GEC, Randall pursued his own experiments at Birmingham until 1943, first to reduce the wavelength to 3 cm by increasing the number of cavities,

then to develop the Sayers methods of strapping. See for instance in [1] p.117 the color photos of some prototypes, which look quite close to your copy.

We can read also in [5] pp. 931-932 that Randall and Boot studied in particular the "secondary emission" phenomena, showing the possibility of putting the magnetron into oscillation without cathode heating, initiating it by an external excitation. It is said p.931 that *"an aluminium cathode with a thin coating of oxide was mounted in a 8 hole E1189-type of block with adjustable cathode ans coupling loop... the magnetron oscillated immediately with a peak output of about 20 kW..."* The initial bombardment was provided with some residual hydrogen gas in the valve, which could be introduced through a special tube. Could we imagine that this gas could be sent through the additional copper tube on the side of your sample ? Is this tube open by a hole through the anode cavity ?

I cannot help thinking that this hypothesis where Randall would have realized your prototype for his study of back bombardment may be quite exciting !

Hypothesis 3: We cannot totally rule out that your sample could have been built at the Bell Labs, in the month following the Tizard mission disclosure, in order to dispel the doubts which had resulted from the Bowen's mis-management (see [4]: "Reproduction of the British magnetron" pp.270-271).

However, the pictures of classical Bell's prototypes seem to look rather different from those of GEC, making this hypothesis 3 the least likely. Perhaps have you more information to say if a US provenance can be eventually taken into account ?

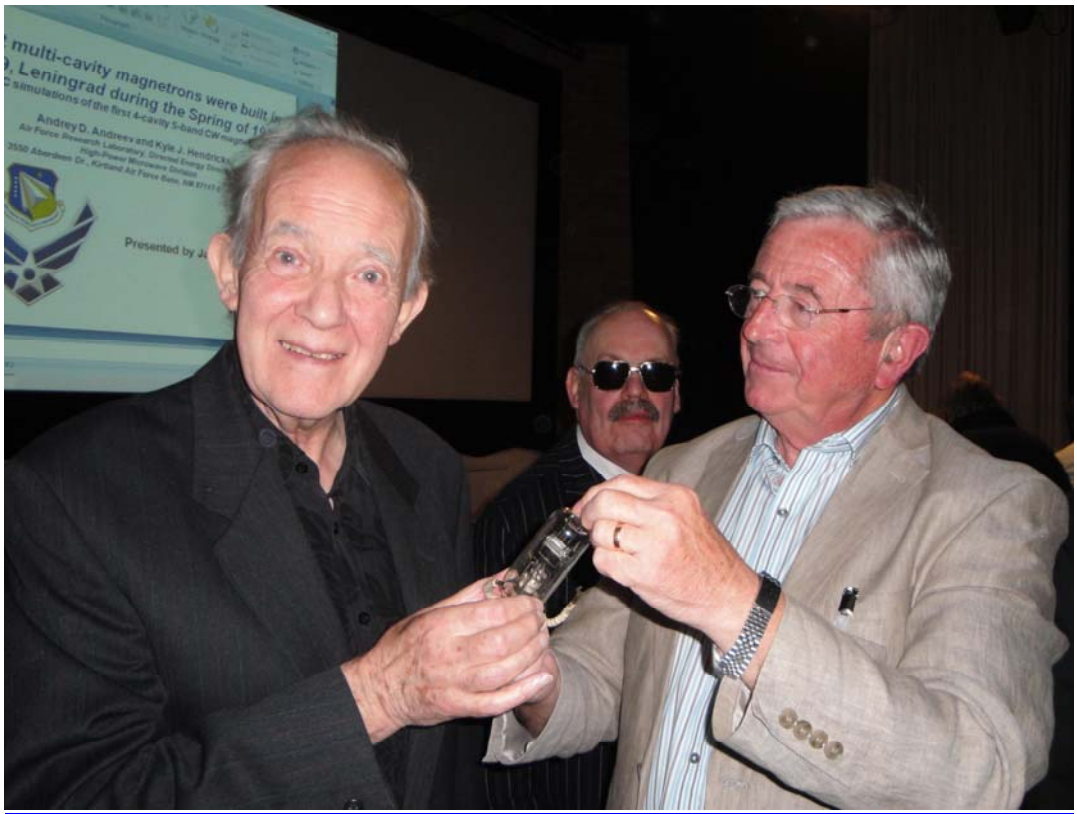
Of course, the definitive answer will be given when we can interpret the number C528 engraved on the copper block of your copy. I cannot distinguish it on your photo, and I don't find this reference anywhere in my documentation (industrialized tubes are generally referred as CV xxx). It would be fine if my Bournemouth contacts could give us the answer !

Please keep me informed of your results in this exciting enquiry

With my best regards

Yves Blanchard

Rod Burman, Mr Mrs Leconte, Mr Mrs Blanchard, Bournemouth.JPG



A.Reddish (GEC) and Y.Blanchard (Thales) re-playing the M16.jpg