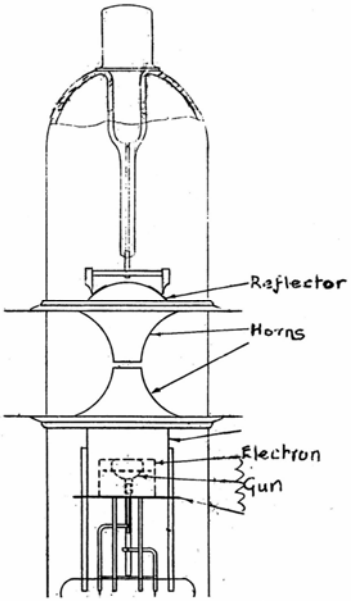
10E/501 (NR89) - Very Early British Klystron = CV11

- The above sample is the only known original 'Sutton tube' reflex klystron still surviving. It can be easily identified for its cup-shaped top reflector.

NR89 was the first reflex klystron. It was designed by Robert Sutton of the Signal School group at Bristol in 1940, soon after the decision of developing a 10 cm radar. The design moved from the documentation of early prototypes recently developed by Varian brothers at Stanford. For the best stability, Sutton decided to use an external high-Q cavity instead of deformable diaphragms. To connect the internal edges to the external cavity he took advantage of the glass-to-metal seal processes recently developed at GEC. He used a CRT gun to generate the electron beam and cup-shaped reflector to keep the beam focused in its way back to the resonator. The deep-drawn horns terminated in a quite large iris. An un-based bulb is in the collection.

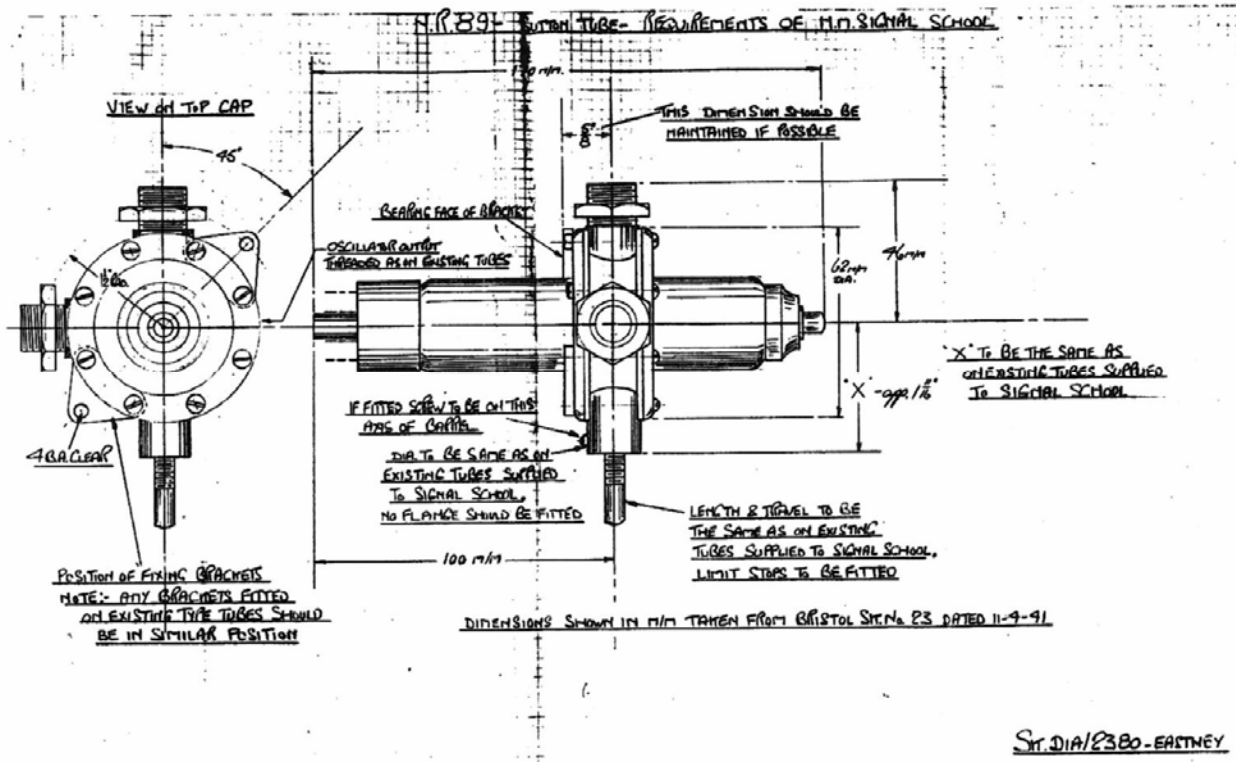


The first oscillator, complete with its external cavity, operated in September 1940. It gave 10 mW in output and could be tuned over a 3% range. In December 1940 the development was complete with tuning range increased to 8%. The klystron, also known as ‘Sutton tube’, was standardized as NR89. The equivalent AM store code 10E/501, also referred to as CV11, was tunable around 3.3 GHz. Sutton oscillators were used in all the early 10 cm radar sets built through 1941, including the early Type 271 Naval radar. Early in 1941 improved variants of NR89, known as Type 8C, were built for Canadian REL by Rogers.

The internal irides were terminated in large holes, to keep low the coupling with the electron beam and hence the noise. The tube oscillated in very high mode due to the long drift space, increased by the cup shaped reflector. Its tuning was critical and required frequent adjustments of the focusing potentiometer. NR89 required to operate about 1700 V, well stabilized. Due to the high resonator voltage, its use was very difficult in airborne application. Nevertheless it was the only component suitable as local oscillator in 10-cm radar receivers through the early steps of the microwave sets and until the late 1941, when the WE 707A and new improved EMI types, as the **CV35** and the **CV67**, were released.

4 V at 1.45 A heater. -275 V reflector.

Pinout: 1 focus grid, 2 and 7 heater, 8 cathode. Reflector to top cap.



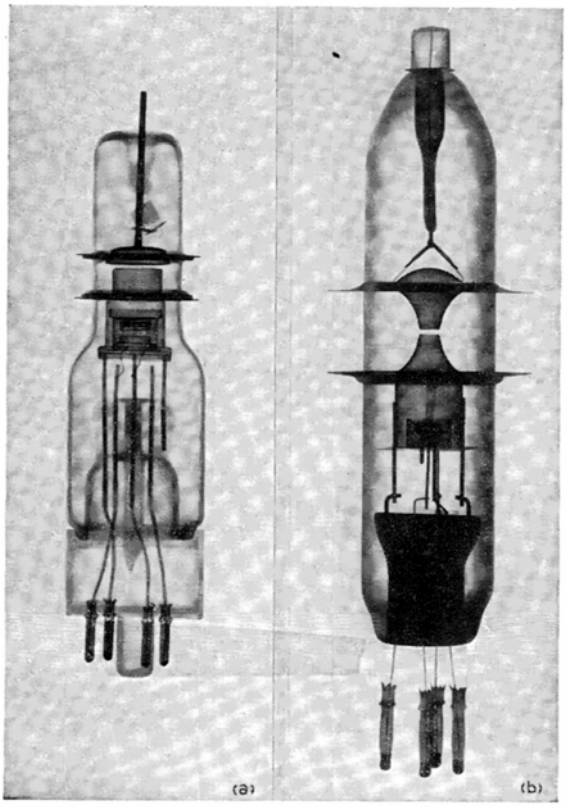


FIG. 11.3–14. X-ray views of early models of reflex oscillator tubes for use with external cavities.

The NR89 'Sutton tube' was the only reflex klystron suitable for use as local oscillator in 10 cm radar receivers from mid 1940 to the late 1941. Here an X-ray image (b) taken at Bell Labs. near to the first Western Electric similar device, the 707A (a), introduced only at the end of 1941.

The collection also includes an unbased early prototype of Sutton tube and some samples of its Canadian **REL 8B** variant. The main difference in the Canadian production was the replacement of the tuning knob with a semi-fixed, factory preset tuner, to prevent mode jumping.

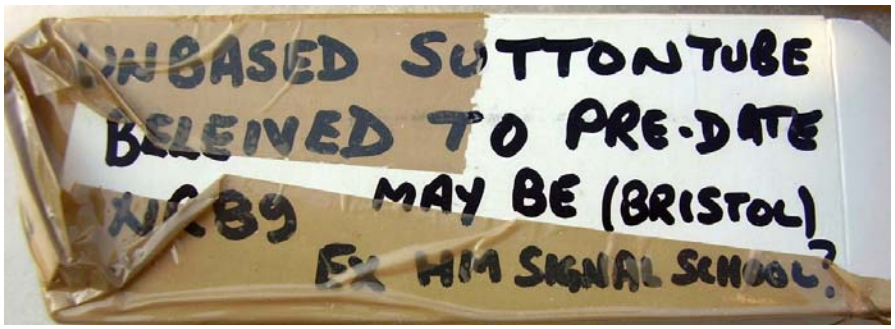
Photos of the REL 8B reflex klystron, directly derived from the Sutton tube, with external shield and semi-fixed tuner, factory-tuned to prevent mode jumping.

Very few information on this Canadian klystron, also known as RT66. Sibley lists four frequency variants from 8A to 8D, presumably to match the frequency of different magnetrons. The shape of the two cavity terminating horns and the cup shaped reflector suggest that it was directly derived from the original British 'Sutton tube'. The REL 8B was manufactured by Rogers for Canadian REL. Almost certainly it was used as local oscillator in the 1941 production of GL 3 gun laying and maybe also in the RX/C naval radar sets designed by REL. The preliminary specs written in 1940 for GL 3 suggested the use of a Northern Electric E1189 magnetron in the transmitter and of components from Bell Lab., crystals and a 1020Y valve as local oscillator, in the receiver. Northern Electric supplied satisfactory samples of its E1189, known as **REL 3D**, early in February 1941. Unfortunately Western Electric, even if already working with linear klystron devices, was not ready to supply a suitable low-noise reflex klystron and its 707A appeared only at the end of 1941. REL could have asked Rogers to make improved copies of the only tube available and certainly working at the time, the British NR89 ‘Sutton tube’. Delivery of the device, identified as tube Type 8, started by April 1941. Some 660 units of GL IIIC sets were delivered to Britain from 1941 under the Lend and Lease Act. Not known the number of naval sets, RX/C and SS/2C, fitted with Type 8 local oscillator.

The electron gun was modified with a second grid, much likely to improve the beam focusing. The resonator was larger, supported by the external aluminum shell and fitted with a knurled tuning knob. Large 4-pin bayonet base and top cap.

In the photos below, the unbased ‘Sutton tube’ lab prototype in the collection is compared with a bulb of REL 8B, to evidence the small mechanical difference in the reflector and in its support.

- Comparison of a Canadian REL 8C internal bulb and the ‘Sutton tube’. There are only minor differences in the position of the exhaust tube and on the use of two rods to hold the reflector in the Canadian version.



The box where the 'Sutton tube' was stored.

Even if the design of the Sutton tube was run at the Bristol Signal School, the production of early prototypes through 1940 was run at the Wembley GEC Research Laboratories, as confirmed in the diary of Clifford Paterson.