7.2 - Radar Tubes: Mixer and Duplexer types

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7.2.1- Mixers

Overall performances of vacuum tube mixers rapidly decay as the frequency increases. In early UHF radars, operating at frequencies of few hundreds megahertz, diodes or triodes of very special design were used, characterized for their very low transit time and low interelectrode capacitance. Some of these devices were designed with small electrode surfaces and cathode-to-anode clearance as low as 0.05 mm, as the British CV58. Very soon, as operating frequencies raised over 1 GHz, they were replaced by point-contact silicon diodes.

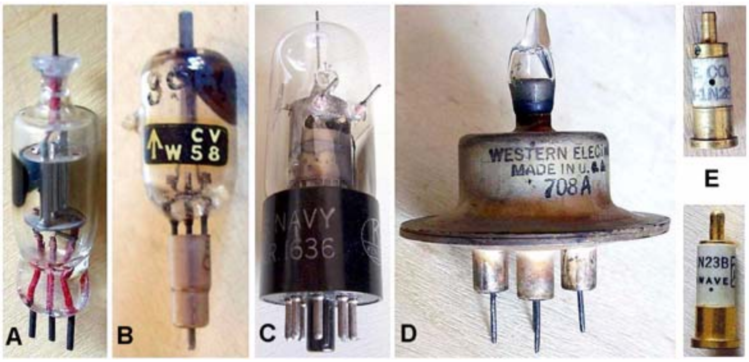

Fig. 7.2.1 - Mixer tubes for radar receivers. A) EA50 is a small diode usable as mixer up to about 200 MHz. It was used in early receivers of the CH radar system. B) CV58 was designed by GEC to operate at higher frequencies, up to 1 GHz. Spacing between anode and cathode was 0.05 mm. C) RCA 1636 was a beam-deflection hexode designed to operate as mixer at 600 MHz in the AN/TPS-3 radar. D) Western Electric 708A was designed to operate as mixer in the early 1 to 3 GHz radars, as early SE, SG, early SJ and early Mk. VIII. E) A couple of silicon diodes commonly used in microwave mixers. The upper one is an 1N28 low noise S-band type. It can be dated to the war period for its primitive British BTH construction, about first half 1941, with the grub screw around the top collar to lock the catwisker supporting rod and the hole in the ceramic body to inject filling wax. (Click on the image to enlarge)

7.2.2 - Tubes for radar duplexers, TRs and ATRs

In this section we find a variety of British and American TR and ATR switches for balanced or coaxial lines and for waveguides. Most of the known radars operate with a single antenna which must be switched from the receiver to the transmitter during the RF power pulse and then back to receiver, to watch for echoes. During the transmission of the power pulse, the receiver must be disconnected, to prevent damages to the mixer or even a simple sensitivity drop due to AGC. At high frequencies switching can be accomplished by properly shorting transmission lines or equivalent waveguides, to obtain open or short at one end. Switches can be vacuum diodes or even spark gaps.

The very early gas switches, as the CV43 and CV1297, directly derived from the 'Sutton tube', built filling an NR89 klystron resonating structure with low pressure water vapour. These gas switches were the forerunners of successive British and American types, where we find improvements in sensitivity, and life by the addition of a keep alive electrode and of ionizing materials. Quite interesting are some very early types, as the RCA 1B25, for balanced lines, and the British type CV8, a micropup hot cathode diode designed to be mounted inside a coaxial line.

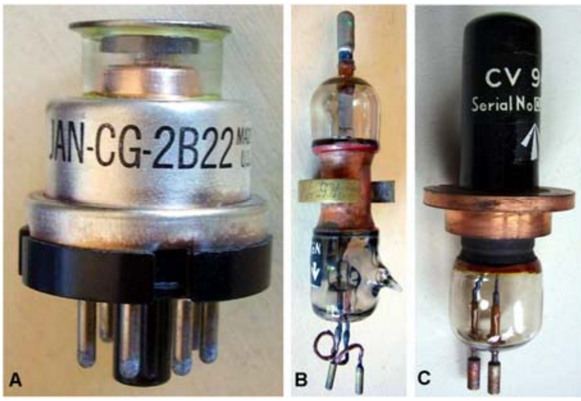

Fig. 7.2.2 - Vacuum diodes used as TR switches. A) 2B22 was a General Electric lighthouse UHF diode, also used as TR switch. B) GEC E1248 coaxial diode, approved as CV8, was designed in 1940 to operate as switch in a coaxial line. No known use in operational equipment. C) Marconi DS103, approved as CV94, was used in Type 960 high power radar, switching 450 kW peak pulses at 90 MHz. (Click on the image to enlarge)

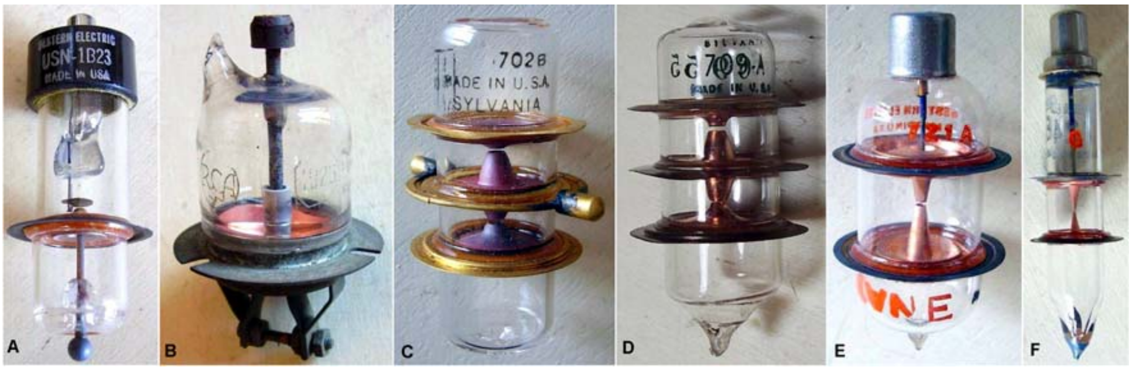

Fig. 7.2.3 - Early American TR switches. A) Western Electric 1B23 was designed to operate from 0.9 to 1.2 GHz depending upon the external cavity. B) RCA 1B25 was registered as a protective tube for balanced transmission lines. C) 702A was the first TR switch designed by Western Electric to operate with a magnetron transmitter in 1941. The above sample is a 702B. D) Western Electric followed a design parallel to that of the British 'Sutton Tube' to develop its 709A S-band TR switch early in 1941. Its electrode assembly was directly derived from one of the WE linear klystrons, as 402A, and the bulb was filled with low-pressure gas. E) 721A was an improved TR switch with temperature compensated gap and keep-alive electrode. F) 724A was the early X-band TR switch designed by Western Electric scaling down the 721A. Replaced by integral cavity types, as 1B24. (Click on the image to enlarge)

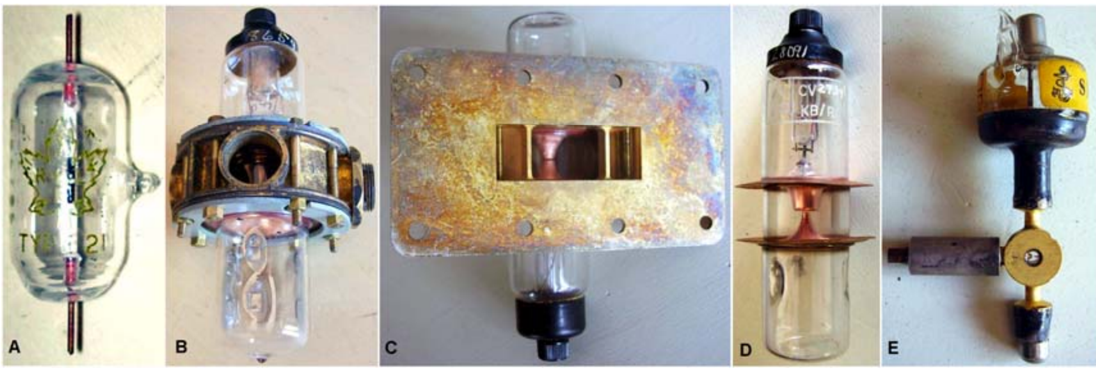

Fig. 7.2.4 - Gas-filled British TR switches. A) REL21 was the Canadian equivalent of British CV1507 gas diode used in the CHL coastal defense system built by REL to protect Panama Canal in WWII. B) CV43 was the early TR switch, known as 'Soft Sutton Tube', designed using the same resonating system of the 'Sutton Tube' klystron in a glass envelope filled with low-pressure water vapour. After the successful test of prototypes in July 1941, the first batch of twelve units was delivered bt E.K.Cole in September. CV43 was used in S-band radar sets until they were equipped with unstrapped magnetrons, NT98 and similar, rated for RF power well under 50 kW. C) CV193 replaced CV43 for power pulses up to 500 kW. Its development started around the end of 1941, with the introduction of strapped magnetrons, as CV56 and CV64. D) CV2739 was a replacement bulb, showing the electrode system. E) VX9106 / CV2330, a TR switch for Q-band, about 33 GHz. (Click on the image to enlarge)

7.2.3 - Resonating cavities

Reference cavities, vacuum sealed and with unloaded Q in the order of 2000, are used in the RF plumbing to stabilize the frequency of the local oscillator.

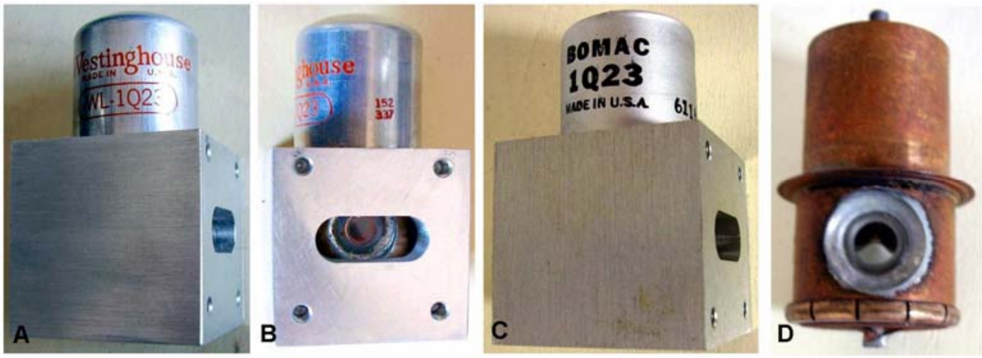

Fig. 7.2.5 - Reference cavities. 1Q23 resonates at 9280 MHz with unloaded Q around 2000. Here three photos of cavities complete with waveguide mount and (D) the photo of the copper resonator. (Click on the image to enlarge)

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