Tube Of The Month

MAGNETRON

Many different devices and circuits were tried in the early days of tube development to circumvent the triode patent. Using magnetism was a promising concept. Before 1920, a GE engineer named Albert Hull developed a split anode diode that used a magnet to produce oscillations. He called it a "magnetron". It showed potential but at very low frequency. Fourteen years later, Hans Hollmann in Germany, used Hull's magnetron concept to make a device that used cavities that would produce oscillations in the UHF and microwave frequencies. As WWII approached, scientists in the UK, US, Germany and Japan were busy trying to improve the device into a practical microwave tube for use in the new RADARS.

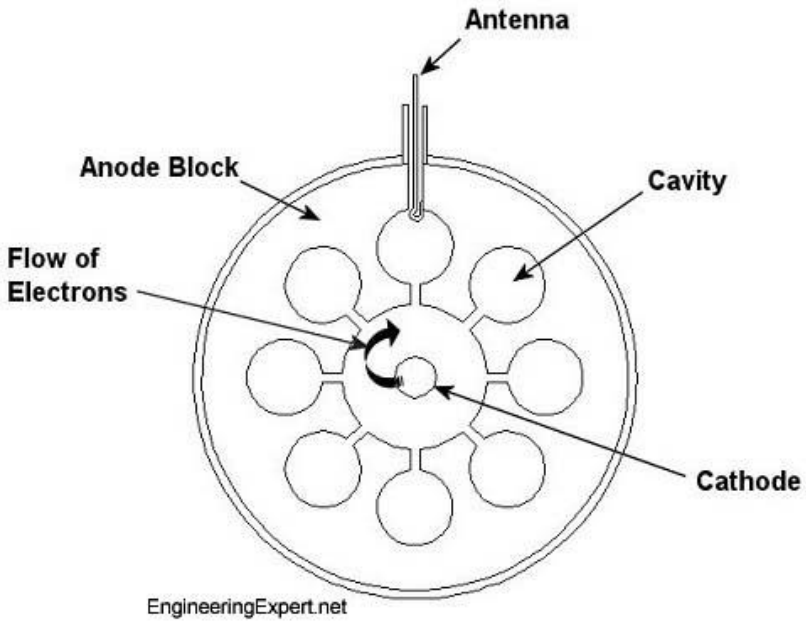
In 1940, John Randall and Albert Boot were working in England on the project and made a cylindrical unit with multiple cavities. Legend has it that they took a cylinder from a Colt revolver as their template. The device worked and many improvements were made to improve power output. Their tubes were shared with their colleagues in the US who further improved the device. Six and eight cavity blocks of copper were machined to the very tight tolerances that were required to maintain frequency control.

A block of copper with a hole drilled through it and a slit cut down one side of the hole is the basic unit. The diameter and length of the hole is an inductor and the opening is a capacitor that will resonate at one frequency. Even numbers of holes were arranged in a circle with the slits opening into a central chamber that houses a cathode. When you blow air into a flute, a small amount of air escapes through a hole and makes a sound. In the cavity magnetron, electrons are emitted by the cathode and are affected by a strong magnet. They travel in all directions, but those that move at an angle will pass by the slits and loose a small amount of energy that will make the cavity resonate. The cavities can be "strapped" together to combine their outputs that is picked up by a small loop in one cavity's wall.

A magnetron is a diode with very high voltages applied to it. If the anode was positive, the coax or waveguide would be at full potential. In use, the anode is grounded and the high voltage is negative and applied to the filament. In a RADAR, the voltage is pulsed at very short durations on the order of a few microseconds.

Wartime production of the WE725A/B magnetron for the AN/APS-15 RADAR was about 300,000 tubes. They operated at 9375 MHz with an output of 55 Kw. It was said that these X-band radars could spot a submarine's periscope at night in the fog.

Visit the museum at http://n6jv.com.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