

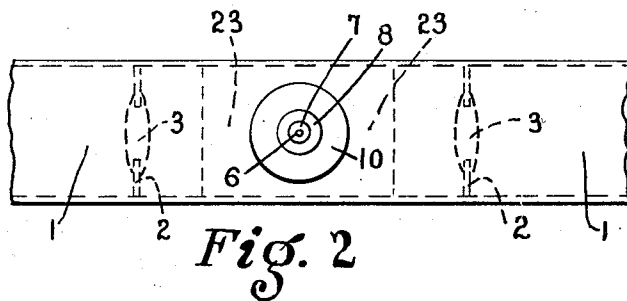
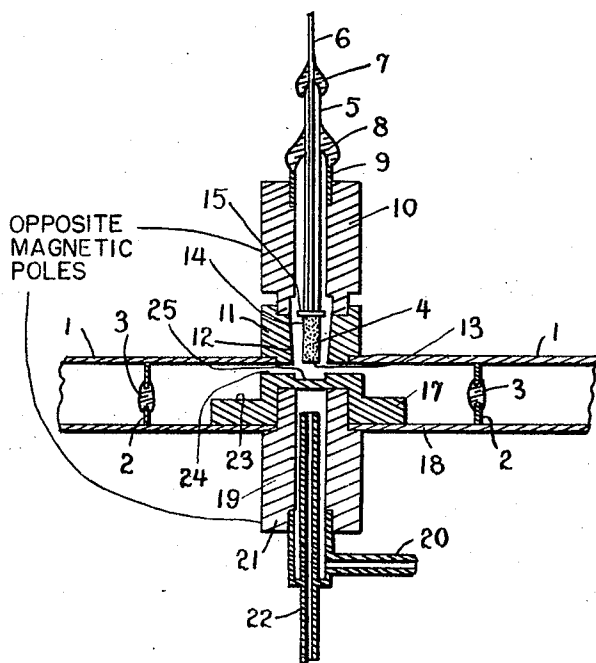
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SWITCH TUBE

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SWITCH TUBE

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This invention relates to tubes for controlling the transmission of radio frequency power through a wave guide or the like upon the application of a proper voltage.

Radio frequency transmission in a wave guide can be blocked, for example, by the introduction across the guide of an electron beam of sufficient density. To use an ordinary electron beam in this manner is difficult because of the high electron density required.

The use of a magnetron type structure with one end open provides a helical type of beam, that is a beam in which the electrons progress not in straight lines, but in a helical path around an axis so that their velocity in the direction of the axis is smaller. This allows a sheath or beam of electrons to build up to high density with a small amount of power.

Other object, features and advantages of the invention will be apparent from the following specification taken in connection with the accompanying drawing in which:

Fig. 1 shows a sectional view of a device according to the invention; and Fig. 2 shows a top view.

In the figures wave-guide 1 is sealed at two spaced planes by the baffles 2, having insulating windows 3, to provide a hermetically sealed space between the said baffles 2, in order to allow the passage of radio frequency energy without leakage of gas. A magnetron type cathode 4 in the form of a metal cylinder closed at one end, and coated with the usual emitting materials, such as the alkaline earth oxides, may be supported at its other end by the lead-in pipe 5 having an axial wire 6. The pipe 5 may be connected directly to the cathode cylinder 4, and the axial wire 6 to one end of the usual heater inside said cylinder 4, the other end of said heater being connected to the cylinder 5 or to cathode 4. The glass bead 7 spaces pieces 5 and 6 apart at their outside ends and provides a seal between them. The somewhat conical glass piece 8 seals the pipe 5 to a metal cylinder 9 spaced from the cylinder 5. Cylinder 9 is sealed into the heavier cylindrical metal block 10, of magnetic materials which at its lower end is sealed to another cylindrical block 11 of non-magnetic metal, concentric with cathode 4, and whose interior surface 12 is tapered somewhat, i. e. conical, so that it is closer to cathode 4 at the closed end 13 of said cathode than to the other end 14. A disc 15 is attached around end 14 of said cathode, somewhat as a flange, to impede the passage of electrons upward.

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The cylindrical block 11 is fitted into a corresponding cylindrical hole of somewhat smaller diameter in the wider side of the wave-guide 1. A stepped cylindrical block 17 is fitted over a corresponding hole in the opposite side 18 of wave-guide 1 as shown and the cylindrical block 19 of magnetic material is passed through the said opening in side 18 of wave-guide 1 and fitted into a cylindrical hole in block 17. A pipe 20 fits into the bottom 21 of cylindrical block 19 in order to allow the flow of water into said block 19 to cool the main anode block 17, and pipe 22 passes through pipe 20 and up into said block 19 as an outlet for the water. The block 17 is stepped up to have a surface 23, another surface 24, and a circular surface 25 depressed from surface 24, and directly in line with the cathode.

The metal pieces 10, 19 are of magnetic material and act as pole pieces having a permanent magnet connected between them to provide a magnetic field along the axis of the cathode 4, pieces 10 and 19 thus constituting opposite magnetic poles. The auxiliary anode cylinder 11 and the main target anode 17 are connected to suitable positive terminals of a direct current of a voltage supply whose negative terminal is connected to the cathode 4, and these electrodes 4, 11 and 17 constitute electrostatic means having parts disposed on opposite sides of the wave-guide. These electrodes coact with the magnetic poles to produce a helical electron beam interrupting the transmission of radio-frequency energy or in the alternative, when the electron current does not flow, provide an open path for the transmission of radio frequency waves along the waveguide 4. The two anodes are shown connected together, but if one be insulated from the other, the target anode 17 may be made less positive than the auxiliary anode 11, thus slowing up the electrons.

Electrons emerging from the cathode 4 would travel radially to the anode 11 were it not for the axial magnetic field which gives the electrons a circular component of velocity around the cathode. The tapering of the cylinder 12 of the dummy anode 11 produces an electrostatic field having an axial component which, together with the effect of space charge, tends to send the electrons outward and downward from the cathode. The resultant of the magnetic and electric fields gives the electrons a helical motion around the cathode and motion outward and downward from the cathode so that they travel in helical paths to form a cylindrical electron sheath or beam. This downward travel is par-

allel to the E-plane of the rectangular waveguide 1. The main anode 17 insures that there will be an axial component of the electrode field sufficient for this purpose when the proper voltage is applied.

My invention may be applied to a coaxial transmission line by having a gap in the center conductor with an electron beam apparatus such as I have described in position to project its beam across the gap to complete the circuit when proper voltages are applied. In that case, my invention can enable the transmission of energy only when the beam is in operation.

What I claim is:

1. A switch tube having a radio-frequency wave transmission line and means secured to the line for producing a helical beam of electrons transversely therethrough to control the passage of radio frequency waves within said line.

2. A switch tube having a section of waveguide and means secured to said waveguide for producing a helical beam of electrons transversely therethrough to block the passage of radio frequency waves within said guide.

3. A switch tube having a waveguide, a cathode secured to said waveguide, an anode about said cathode for producing a radial electrostatic field about said cathode, means fixed in relation to the waveguide for directing a magnetic field across said waveguide and along said cathode, and means at the side of said waveguide opposite said cathode for producing an axial electrostatic field along and beyond said cathode to produce a helical beam of electrons transversely through said waveguide to reduce the flow of radio frequency energy therethrough.

4. The combination of claim 2, in which the axis of the helical beam is parallel to the E-plane of the waveguide.

5. In combination, a rectangular waveguide having two sides relatively wider than the other two sides, an opening in one of the wider sides of said guide, a metal anode of circular inner cross-section extending outward from said opening, a cylindrical cathode concentric with said anode, a second anode projecting from the other of the wider sides of said wave-guide, in register with but spaced axially from said cathode, and windowed baffles hermetically sealing said waveguide in place spaced from and on either side of said second anode.

6. A switch tube having a waveguide provided with hermetically sealed windows in its extremities, whereby radio frequency waves may be propagated through the waveguide longitudinally and enabling evacuation of the waveguide, and means for producing a helical beam of electrons transversely through the waveguide to interrupt the transmission of the radio frequency waves, said means including a cathode positioned at one side of the waveguide and anodes at the same and at the opposite side of the waveguide as the cathode, whereby a portion of the waveguide provides a clear path for the radio frequency waves while

there is no electron beam and a high density electron beam is economically established when the wave transmission is to be interrupted.

7. A switch tube having a radio frequency wave transmission line, means for producing a helical electron beam transversely through the transmission line when transmission is to be interrupted, said means including pole pieces for directing a magnetic field transversely of the transmission line, and electrostatic electrodes at opposite sides of the transmission line in the region of said directing means.

8. A switch tube having a length of waveguide and combined electrostatic and magnetic means for producing a helical electron beam transversely of said waveguide and having mutually separated portions disposed at opposite sides of said length of waveguide providing an open path for the transmission of radio frequency waves when the helical beam-producing means is quiescent.

9. A switch tube having an evacuated waveguide provided at its longitudinal extremities with windows enabling the longitudinal transmission of radio frequency waves, and helical electron beam-producing means having magnetic and electrostatic components disposed at opposite sides of said waveguide and mutually separated to provide a free transmission passage for the radio waves when the electron beam is not established.

10. A switch tube having an evacuated waveguide provided at its longitudinal extremities with windows for longitudinal transmission of radio frequency waves, and means for establishing a high-density electron beam transversely of the waveguide when transmission is to be interrupted, said means including co-axial magnetic and electrostatic devices disposed transversely of said waveguide.

11. In combination, a rectangular wave guide having two sides relatively wider than the other two sides, an opening in one of the wider sides of said guide, an internally tapered metal anode of circular cross-section extending outward from said opening, a cylindrical cathode concentric with said anode, a second anode projecting from the other of the wider sides of said wave-guide, in register with but spaced axially from said cathode, and windowed baffles hermetically sealing said waveguide in places spaced from and on either side of said second anode.

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