Klystron Amplifier

Klystron amplifiers are high power microwave vacuum tubes. Klystrons are velocity-modulated tubes that are used in some radar equipments as amplifiers. Klystrons make use of the transit-time effect by varying the velocity of an electron beam. A klystron uses one or more special cavities, which modulate the electric field around the axis the tube.

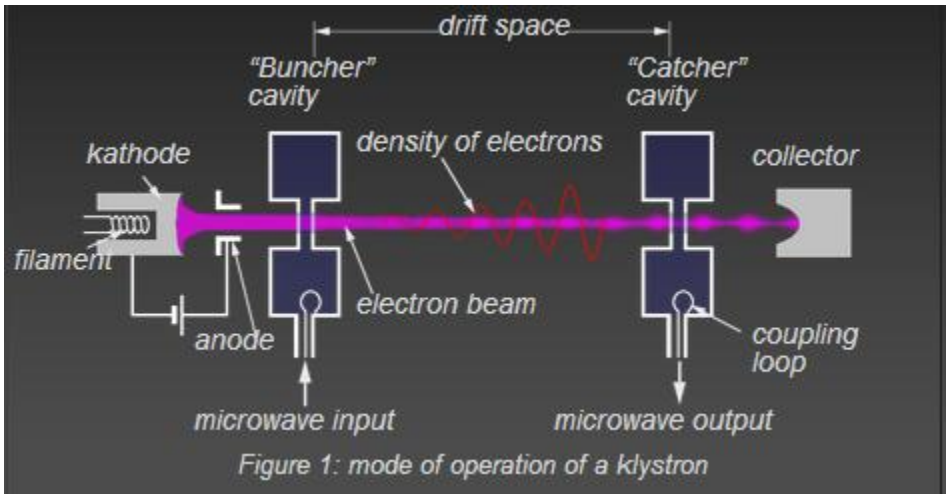

Figure 1: mode of operation of a klystron

Due to the number of the resonant cavities klystrons are divided up into:

- Multicavity Power Klystrons
- Repeller Klystron
- Two-Cavity Klystron

A klystron uses special cavities which modulate the electric field around the axis the tube. In the middle of these cavities, there is a grid allowing the electrons to pass. The first cavity together with the first coupling device is called a "buncher", while the second cavity with its coupling device is called a "catcher".

The direction of the field changes with the frequency of the "buncher" cavity. These changes alternately accelerate and decelerate the electrons of the beam passing through the grids. The area beyond the buncher grids is called the "drift space". The electrons form bunches in this area when the accelerated electrons overtake the decelerated electrons.

The function of the “catcher” cavity is to absorb energy from the electron beam. The “catcher” grids are placed along the beam at a point where the bunches are fully formed. The location is determined by the transit time of the bunches at the natural resonant frequency of the cavities (the resonant frequency of the catcher cavity is the same as the buncher cavity).The collector collect the energy of the electron beam and change it into heat and X radiation.

Klystron amplification, power output, and efficiency can be greatly improved by the addition of intermediate cavities between the input and output cavities of the basic klystron. Additional cavities serve to velocity-modulate the electron beam and produce an increase in the energy available at the output.

Repeller Klystron

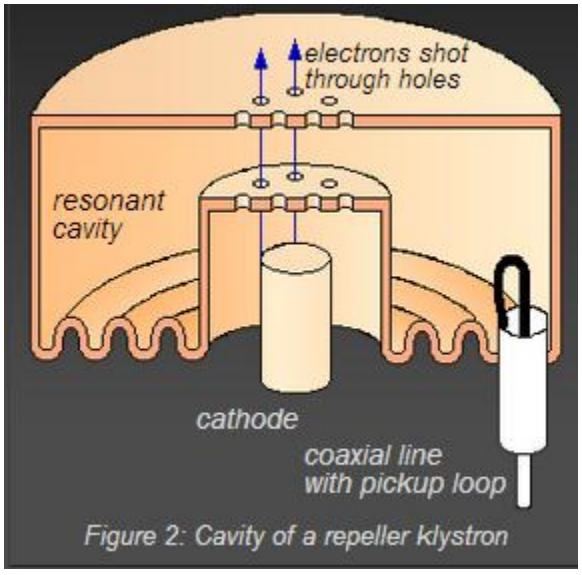

Figure 2: Cavity of a repeller klystron

Another tube based on velocity modulation, and used to generate microwave energy, is the reflex klystron (repeller klystron). The reflex klystron contains a reflector plate, referred to as the repeller, instead of the output cavity used in other types of klystrons. The electron beam is modulated as it was in the other types of klystrons by passing it through an oscillating resonant cavity, but here the similarity ends. The feedback required to maintain oscillations within the cavity is obtained by reversing the beam and sending

it back through the cavity. The electrons in the beam are velocity-modulated before the beam passes through the cavity the second time and will give up the energy required to maintain oscillations. The electron beam is turned around by a negatively charged electrode that repels the beam ("repeller"). This type of klystron oscillator is called a reflex klystron because of the reflex action of the electron beam.

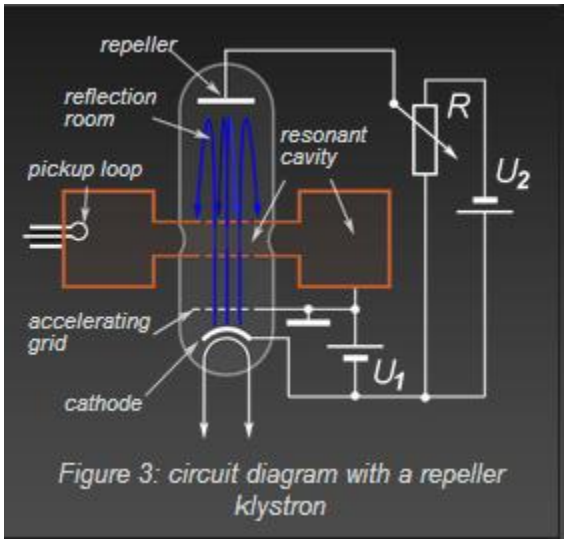

Figure 3: circuit diagram with a repeller klystron

Three power sources are required for reflex klystron operation:

1. filament power,
2. positive resonator voltage (often referred to as beam voltage) used to accelerate the electrons through the grid gap of the resonant cavity, and
3. negative repeller voltage used to turn the electron beam around.

The electrons are focused into a beam by the electrostatic fields set up by the resonator potential (U2) in the body of the tube.

The accompanying graphic shows a circuit diagram with a repeller klystron using a so called "doghnut"-shaped cavity resonator.

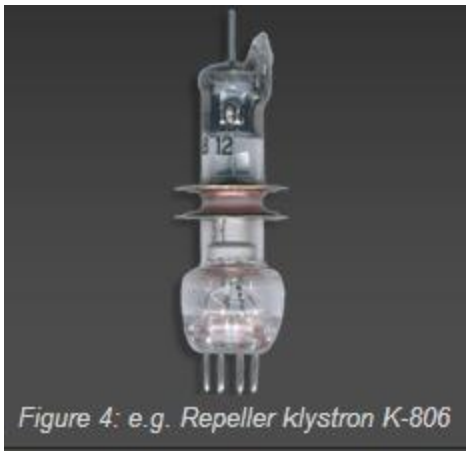

Figure 4: e.g. Repeller klystron K-806

Source:
http://www.radartutorial.eu/08.transmitters/Klystron.en.html