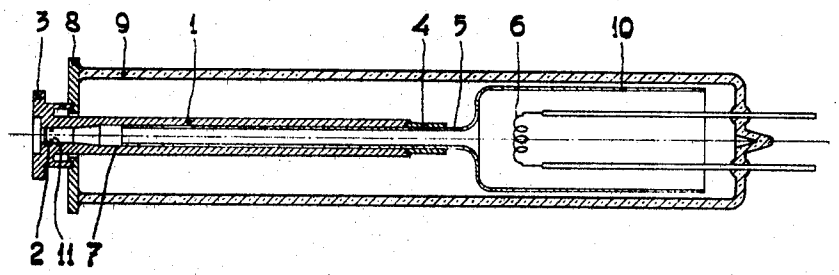
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NOISE GENERATOR FOR MICROWAVES COMPRISING A GAS DISCHARGE TUBE WITHIN A WAVEGUIDE

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NOISE GENERATOR FOR MICROWAVES COMPRISING A GAS DISCHARGE TUBE WITHIN A WAVEGUIDE

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5 Claims. (Cl. 331—78)

The invention relates to a noise generator for microwaves, in which the microwave radiation produced in the positive column of a gas discharge is collected in a wave-guide.

Such a noise generator is used in measuring the noise figure of millimeter wave apparatus, for example radar receivers and also as a standard noise source in plasma physical investigations. The positive column of a gas discharge is particularly suitable because the equivalent noise temperature is high and external factors, such as the value of the discharge current, the operating voltage and the ambient temperature, have small effect upon the noise temperature and the matching. In the millimeter wave range the positive column may be considered as a source of black radiation having a very high equivalent temperature closely approximating to the electron temperature of the plasma. The electron temperature is substantially determined by the gas used, at least under conditions chosen for the column of a noise generator, and it is higher according as the gas atoms are lighter.

For a noise generator for frequencies up to about 40 g.c./s. (wavelength 7.5 mms.) it is known to use an arrangement in which a long thin glass tube in which the gas discharge is produced is passed at a particular angle through a waveguide so that the part of the column surrounded by the waveguide is completely matched, that is to say, delivers its entire noise energy to the wave-guide.

At higher frequencies, however, difficulties are met with. In view of the high noise figures in this range a high temperature is desired, which is also necessary for plasma research. However, the temperatures obtained with the aid of the known arrangements are too low. It is known that the noise temperature can be increased by producing the gas discharge in a narrow tube and by using a gas having a small collision cross section, for example a light rare gas. In this case, however, the free path in the gas is too large as compared with the wavelength so that at a high frequency the high electron temperature cannot be fully utilized. The noise generator in accordance with the invention provides a solution of this difficulty.

According to the invention the anode of the gas discharge produced in an insulating tube is located within the wave guide. This provides the advantage that the length of the positive column in the wave-guide can be varied so that the equivalent noise temperature closely approximates the electron temperature with the result that the noise energy is completely given up to the wave-guide at any frequency.

In particular the inner surface of the wave-guide serves as the anode of the gas discharge. This prevents the occurrence of losses and reflections at the point at which the anode is separately brought out.

In a special embodiment of the invention the direction of the gas discharge coincides with the longitudinal axis of the wave-guide. This provides the advantage that the wave-guide is filled as completely as possible with the positive column of the gas discharge.

In the arrangement in accordance with the invention the high-frequency noise energy is derived through a mica window in contradistinction to the known arrangements in which the positive column is bounded by a glass tube. The positive column is bounded within the wave-guide by a thin-walled insulating tube. This tube has to be thin-walled in order to prevent it from interfering with the field of the wave-guide. The tube is preferably made of quartz. In the arrangement in accordance with the invention the wave-guide forms part of the discharge vessel.

In order that the arrangement may readily be carried into effect, an embodiment thereof will now be described, by way of example, with reference to the accompanying diagrammatic drawing, the single figure of which is a longitudinal sectional view of a noise generator in accordance with the invention.

Referring now to the figure, a copper wave-guide **1** of circular cross section at one end is closed by a mica window **2** and provided with a flange **3** for coupling to a measuring circuit (not shown). A thin-walled tube **5** of vitreous quartz is inserted in the wave-guide **1** and held in position with respect to this wave-guide by clamping springs **4** which engage the wall of the wave-guide The thin-walled tube merges into a widened part **10** surrounding an oxide cathode **6** of the gas discharge. A part **7** of the inner surface of the wave-guide immediately beyond the end of the vitreous quartz tube acts as the anode. The assembly is enclosed by a glass envelope **9** and a molybdenum disc **8** secured to the flange **3**. The positive column is situated in the vitreous quartz tube, that is to say, along the axis of the wave-guide. The length of the vitreous quartz tube is proportioned so that the equivalent noise temperature is about equal to the electron temperature. The noise power reaches the measuring circuit through the mica window **2**, which is provided with a tuned diaphragm **11**, i.e., an apertured partition which matches the impedance of the waveguide to another waveguide (not shown) coupled to it through mica window **2** to restrict the reflection losses.

In a particular embodiment the noise generator is filled with neon at a pressure of 20 cms. of mercury while the tube **5** has a length of 80 mms. and a wall thickness of 0.2 mm. The diameter of the wave-guide **1** is 4 mms. The discharge current is 75 ma., the operating voltage 150 volts and the equivalent noise temperature 21,000° K.

What is claimed is:

1. A microwave noise generator comprising a wave-guide closed at one end by a microwave energy transmissible window, an ionizable medium at least partly contained within the wave-guide, and means to produce a positive column discharge in said ionizable medium comprising a tubular insulating member having an open end in the wave-guide spaced from the window and extending partly within a portion of the wave-guide surrounding the ionizable medium, a cathode within the tubular insulating member adjacent the other end of the wave-guide, and an anode adjacent the end of the tubular insulating member and within the wave-guide.

2. A noise generator as claimed in claim **1**, in which

a portion of the inner surface of the wave-guide serves as the anode of the gas discharge.

3. A noise generator as claimed in claim **1** in which the direction of the gas discharge coincides with the longitudinal axis of the wave-guide.

4. A noise generator as claimed in claim **1** in which the wave-guide is circular and the insulating member is a vitreous quartz tube.

5. A noise generator as claimed in claim **4** in which the ionizable medium is neon at a pressure of about 20 cms. Hg.

References Cited by the Examiner

UNITED STATES PATENTS

2,706,782	4/1955	Mumford	331—78
2,842,712	7/1958	Muldoon et al.	331—78
2,872,581	2/1959	Page et al.	331—78

FOREIGN PATENTS

599,534	6/1960	Canada.

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