Dec. 20, 1960 H. C. ALEXANDER ET AL 2,965,787

GASEOUS DISCHARGE DEVICE

Filed July 14, 1959

2 Sheets-Sheet 1

FIG. 1

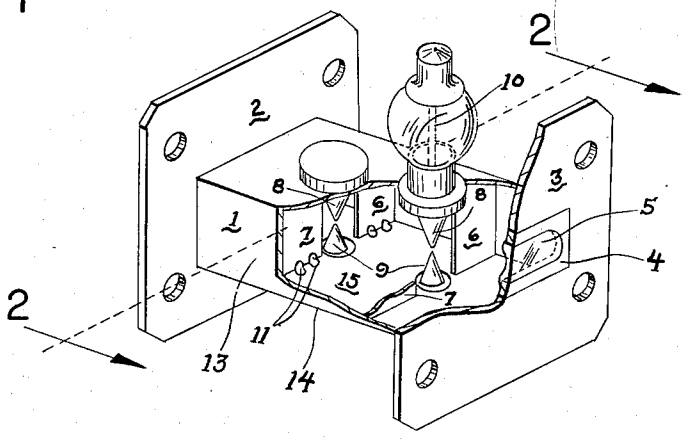
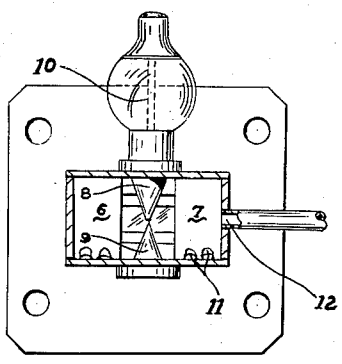


FIG. 2



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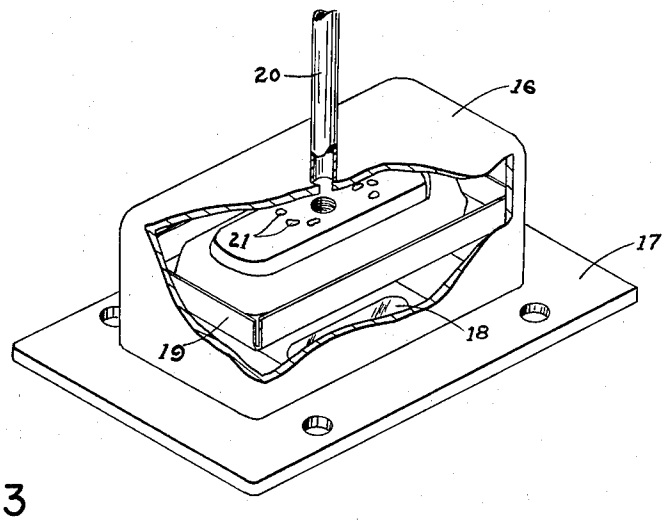


FIG. 3

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GASEOUS DISCHARGE DEVICE

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4 Claims. (Cl. 313—174)

The present invention relates to gaseous discharge devices and more particularly to a means for improving deionization characteristics in such devices.

Present day radar systems commonly employ gaseous discharge devices to produce the rapid switching times necessary for single antenna operation. The transmit-receive or TR tube protects the sensitive receiving apparatus by means of an intense ionized discharge extending across the transmission path. Such tubes generally employ an electron capture agent such as water vapor, in the gaseous atmosphere to enhance the deionization or recovery time between the transmission cycles. The water vapor content, however, has been observed to change after relatively short periods of operation. As a result the recovery time characteristic will rise sharply, thereby reducing the usefulness of such tubes.

It is an object of the invention to provide an improved gaseous discharge switching device having means for the stabilization of the water vapor pressure in the ionizable atmosphere.

A further object is to provide a gaseous discharge switching device with longer periods of operation without a sharp increase in the recovery time characteristics.

The objects enumerated will be attained in devices of the character to be described through the depositing of a finely divided hygroscopic salt on certain structural members. An example of the compound described is calcium chloride and the theoretical explanation of the mechanism involved is presumed to be one of replenishment. With other words, the calcium chloride is applied in an aqueous solution and dried within the tube envelope thereby resulting in the chemical combined with a residual amount of water vapor. The ionizable gas is then added with a small percentage of water vapor, or there will even be a certain amount of water vapor occluded within the metallic envelope. The combined water and the water vapor in the gaseous state tend to reach a state of equilibrium at a certain vapor pressure. Loss of water vapor in the gaseous state due to the "clean-up" phenomenon will result in replenishment through the release of water in the combined state by the compound. In this manner the vapor pressure equilibrium is reestablished almost indefinitely since only minute amounts are needed to maintain the stabilized condition. As a result of this mechanism, tubes have consistently operated beyond conventional 500 hour life limits to 1000 hours or better without any deterioration in the recovery time readings. It has been also noted that tubes fabricated in accordance with the invention will operate at varied temperatures ranging from —10° C. to 85° C.

Other objects, features and advantages will be apparent after consideration of the following detailed description and reference to the appended drawings, in which:

Fig. 1 is a perspective view of an illustrative transmit-receive tube embodiment;

Fig. 2 is a cross-sectional view along the line 2—2 in Fig. 1; and

Fig. 3 is a perspective view of an alternative embodiment.

Referring to the drawings, Fig. 1 illustrates a transmit-receive device of the broadband type suitable for operation over a relatively wide range of microwave frequencies. This class of tubes characteristically have a length of rectangular waveguide **1** with mounting flanges **2** and **3** disposed adjacent to the ends thereof. Flange **2** is considered as the input flange coupled to the transmitter, while the receiving apparatus is coupled to the output flange **3**. A metallic frame **4** having a centrally located resonant aperture enclosed by a dielectric window **5** is disposed within each flange to thereby form a vacuum tight enclosure. Within waveguide **1**, a plurality of inductive iris members **6** and **7** and capacitive conical electrode members **8** and **9** are spaced at intervals of approximately one-quarter of a wavelength to provide the remaining resonant circuit elements. An ignitor electrode **10** is mounted with its inner end disposed in close proximity to the apex of the conical electrode **8** adjacent output flange **3**. This electrode provides a means for partial ionization of an ionizable atmosphere contained within the enclosure and is activated by a direct current voltage supply. The practice of the invention will now be explained, reference being had to Fig. 2 where the structural members adjacent to the ignitor electrode **10**, are shown. A finely divided chemically pure hygroscopic salt, namely anhydrous calcium chloride is dissolved in water to form a solution having a ratio of 90 grams per liter. Using a suitable instrument, such as a syringe a plurality of drops **11** of the solution are deposited through exhaust tubulation hole **12** onto the joining edges of the iris members **6** and **7** and the waveguide narrow wall **13** and wide wall **14**. The chamber **15** defined between opposing faces of iris members **6** and **7** will, therefore, contain a concentration of the chemical additive. The tube is then heated in an oven at a temperature of from 100–105° C. to dry the calcium chloride solution on the applied surface.

To complete fabrication of the tube, the following exhaust and filling procedure is outlined:

(1) Exhaust the tube for a minimum of 45 minutes.
(2) Flush with 1.0 mm. of water for 5–10 minutes.
(3) Re-exhaust tube for approximately 5 minutes.
(4) Fill with desired gas filling; for example, one millimeter hydrogen and three millimeters or argon for a total pressure of 4 millimeters.
(5) Tip off and seal exhaust tubulation.

Another embodiment of the invention is shown in Fig. 3, illustrating an anti-transmit-receive or ATR tube. A shorted section of waveguide **16** one-quarter of a wavelength long with a flange **17** and window **18** has an internal intermediate diaphragm **19** adjustable to tune the tube to resonance during manufacture. An exhaust tubulation **20** provides access to internal structure. A plurality of drops **21** of the calcium chloride solution may be deposited on the diaphragm member **19**, on the surface opposed to the rear wall. The subsequent operations will follow in accordance with the TR tube processing and the gaseous fill may be varied to provide the desired characteristics.

Gaseous discharge switching devices have demonstrated excellent electrical characteristics over longer periods of operation as a result of the stabilization of the water vapor pressure through the use of the hygroscopic salt of the invention. The phenomena involved is thought to be one of replenishment as presently understood and we do not wish to be limited solely to the following theoretical considerations. Apparently, the combined water in the calcium chloride and gaseous water vapor occluded within the tube envelope reach a condition of

equilibrium at a certain pressure. Disturbance of this equilibrium by loss of water vapor in the gaseous state results in release of the combined water in an effort to reestablish the equilibrium. Since the amounts needed to maintain the constant equilibrium are comparatively small relative to the amount of water available in the combined state, there exists an unlimited supply to increase tube life.

While a particular embodiment has been described relating to a metallic envelope, the invention will be equally applicable to various microwave switching devices having dielectric envelopes with similar results.

What is claimed is:

1. A transmit-receive switching tube comprising a metallic hermetically sealed envelope having a plurality of spaced flat metallic iris plates disposed therein, an ionizable atmosphere with water vapor contained within said envelope and a plurality of drops of an aqueous solution of calcium chloride deposited on oppositely disposed surfaces of said plates and dried thereon to provide means for stabilizing the water vapor pressure during the operation of the tube.

2. A transmit-receive tube comprising a hermetically sealed rectangular waveguide envelope, plural spaced flat metallic plate members extending transversely within said envelope at intervals of a quarter of a wavelength, an ionizable atmosphere with water vapor contained within said envelope and a quantity of calcium chloride deposited on wall structure in the area defined between said plate members to provide means for stabilizing the water vapor pressure during operation of the tube.

3. An anti-transmit receive tube comprising a hermetically sealed envelope having a closed end wall at one end and a dielectric window assembly enclosing the other end, a metallic diaphragm member disposed intermediate the ends of said envelope, an ionizable atmosphere with water vapor contained within said envelope and a quantity of calcium chloride deposited on wall structure in the area defined between the diaphragm member and end wall to provide means for stabilizing the water vapor pressure during operation of the tube.

4. A transmit-receive switching tube comprising a hermetically sealed envelope containing an ionizable atmosphere with water vapor, and a quantity of anhydrous calcium chloride deposited within said envelope to provide means for stabilizing the water vapor pressure during operation of the tube.

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