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[54] **ELECTRODELESS GAS DISCHARGE DEVICES EMPLOYING TRITIUM AS A SOURCE OF IONS TO PRIME THE DISCHARGE**

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333/13

[51] Int. Cl. **H01p 1/14**

[58] Field of Search **313/54, 223; 333/13; 315/39**

[56] **References Cited**

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[57] ABSTRACT

An electrodeless, halogen gas microwave-induced discharge device, particularly adapted for use as a power limiter stage, which has no wires connected to it. Incorporated into the discharge device is a free electron emitter comprising tritium adsorbed into a layer of material such as titanium or yttrium. The tritium yields sufficient initiatory electrons to prime the microwave gap so as to yield a short interval for radio-frequency breakdown of the gas, and to yield repeatable discharge characteristics with each incident radio-frequency pulse.

7 Claims, 3 Drawing Figures

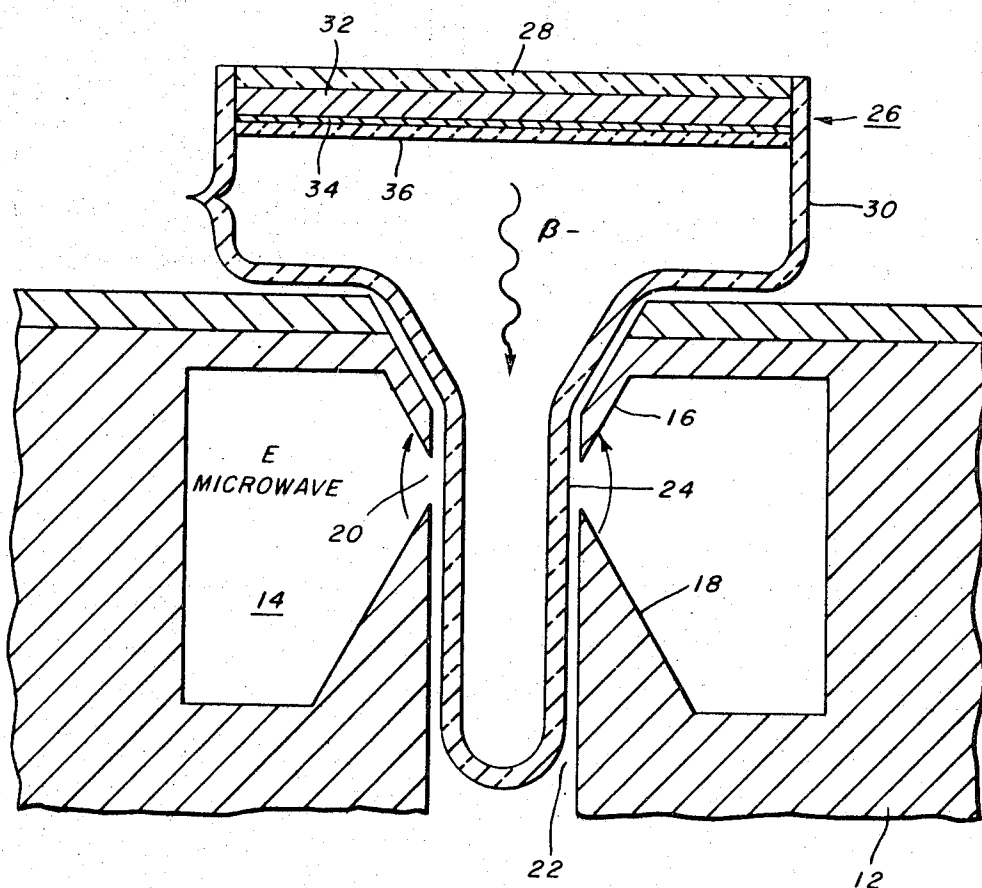


FIG. 1.

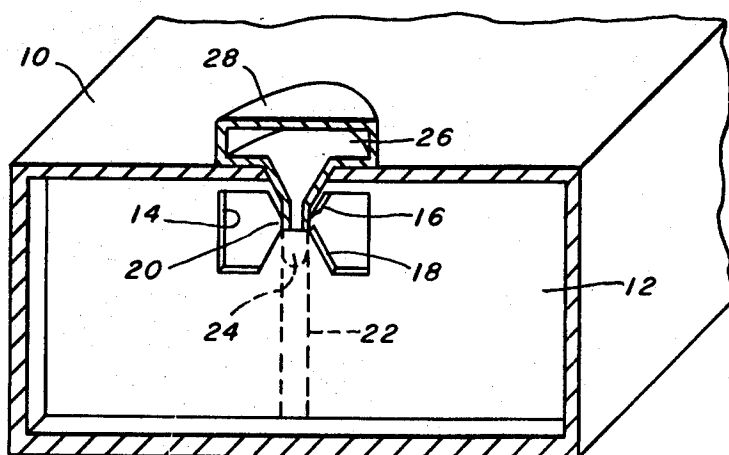


FIG. 3.

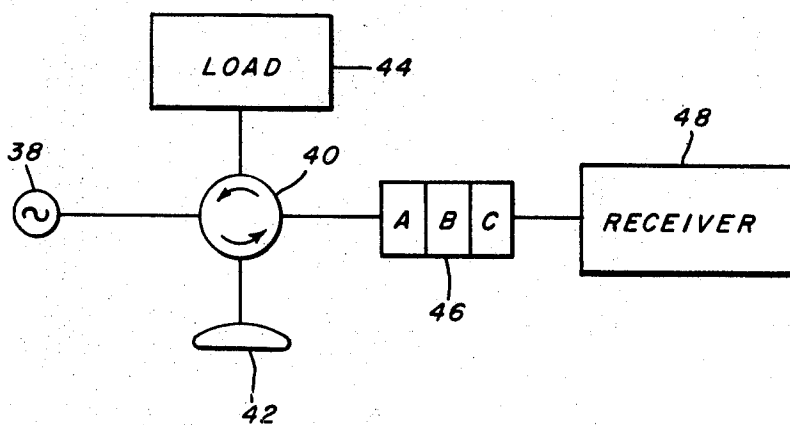
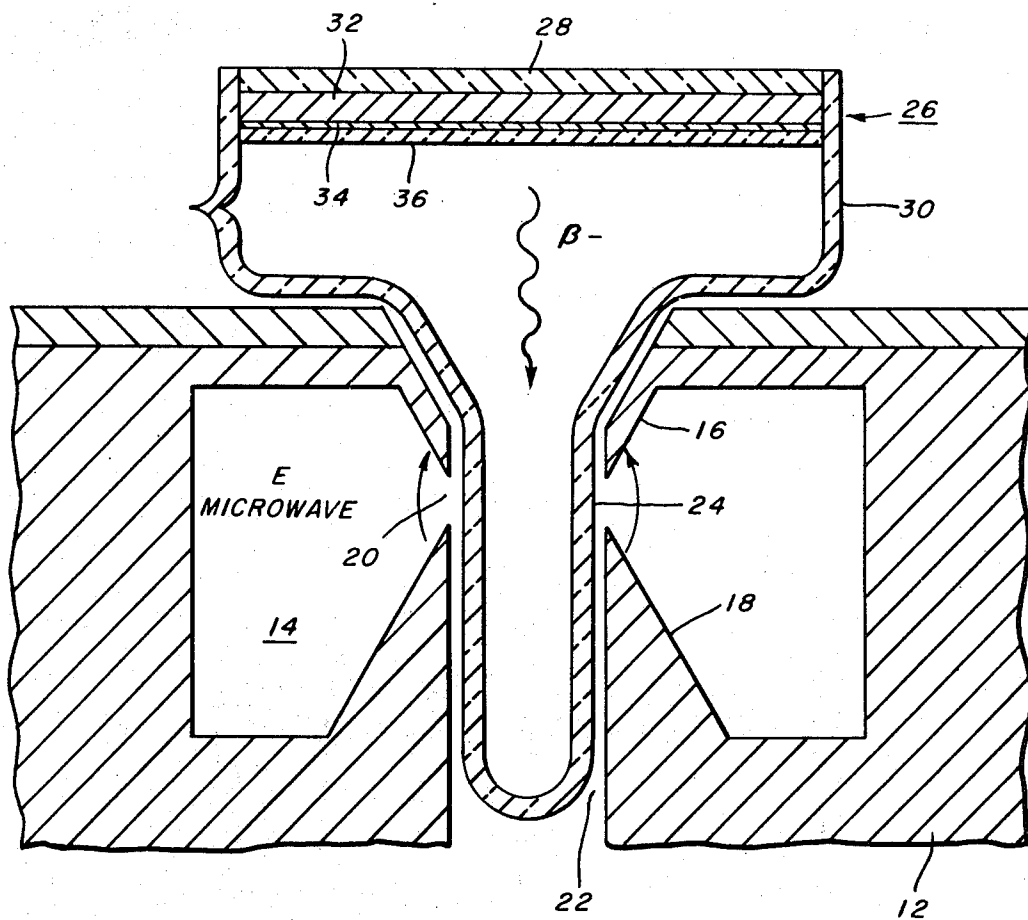


FIG. 2.



ELECTRODELESS GAS DISCHARGE DEVICES EMPLOYING TRITIUM AS A SOURCE OF IONS TO PRIME THE DISCHARGE

BACKGROUND OF THE INVENTION

As is known, there are various classes of electrical devices presently in use which depend upon ignition of an electrical gas discharge (i.e., the formation of a gaseous plasma) for their operation. One such device is a keeplive stage used as a radar receiver protector. Such protectors are placed in a wave guide leading from a circulator to the receiver and consist of a quartz or the like capsule containing a halogen gas, preferably chlorine. Assuming that a suitable source of ions or electrons is present to prime the discharge within the gas, and assuming that the capsule is disposed in an aperture formed in a thin iris plate in the path of wave energy passing through the wave guide, a high energy pulse (such as that which would damage the receiver) will ionize the halogen gas. The resulting increase in electron density represents an increase in permittivity of the aperture in the iris plate, changing its capacitance and detuning the circuit. This causes the high energy pulse, which might otherwise damage the receiver, to be reflected. On the other hand, a low energy pulse, such as that reflected as an echo from a distant target, will not cause ionization of the halogen gas with the result that the low energy pulse will pass through the iris plate to the receiver, as is intended.

A keeplive stage of the type described above depends for its operation upon ignition of an electrical gas discharge. Furthermore, the device requires a source of ions or electrons to prime the discharge, the performance of the device being beneficially affected by increased availability of priming or initiatory electrons.

The development of practical radar receiver protectors using halogen gases has not as yet been realized due to the fact that in the past the source of priming electrons to the electron gap has been a cold-cathode metal electron discharge. The chlorine, being highly reactive especially in the ionized state, forms a metallic chloride at the cathode. This erodes the cathode and dissipates the gas, seriously limiting operating life and impairing reliability. The reliability is impaired because reproducibility of the discharge is poor as the eroding electrode geometry changes.

SUMMARY OF THE INVENTION

In accordance with the present invention, a gaseous discharge device is provided which depends for its operation upon a source of priming radiation, and wherein the priming radiation source comprises tritium adsorbed into a layer of material such as titanium or yttrium. The tritium provides only low energy radiation (i.e., electrons) with penetrating power sufficiently small to allow high activities of radiation to be used safely. The gas, usually a halogen such as chlorine, is contained within a quartz or the like capsule having a layer of titanium or yttrium with adsorbed tritium on an interior surface thereof. The low energy radiation is introduced into the gas within the capsule through a thin insulating surface such as silica. With an arrangement of this type, the chemical composition and presence of the original fill gas is not changed regardless of the frequency or number of pulse breakdowns of the gas.

Further, in accordance with the invention, an electrodeless radar receiver protector is provided using a halogen gas and incorporating as a source of priming electrons tritium adsorbed into a layer of titanium or yttrium. The successful realization of the invention, when incorporated into a multistage radar receiver protector, will yield an all-halogen tube with an extremely fast recovery period and long operating life since in no part of the device does any gas come into contact with a metal surface. Furthermore, the invention enables an assured first pulse breakdown whether the stage has been passive for periods of microseconds or months and reproducible discharge characteristics on a pulse-to-pulse basis even though the time between successive pulses is from microseconds to seconds.

The above and other objects and features of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings which form a part of this specification, and in which:

FIG. 1 is an illustration of the electrical discharge device of the invention as applied to a keeplive stage positioned within a wave guide leading to a radar receiver or the like;

FIG. 2 is an enlarged cross-sectional view showing the manner in which tritium is adsorbed into a layer of titanium or yttrium on an interior surface of the keeplive stage of FIG. 1; and

FIG. 3 illustrates a typical application of the gaseous discharge device of the invention.

With reference now to the drawings, and particularly to FIG. 1, there is shown a wave guide section 10 having a thin iris plate or resonant element 12 extending across its width and perpendicular to the axis of the wave guide. For X-band operation, the thickness of this element may typically be about 60 mils. Provided in the iris plate 12 is an aperture 14 provided at its top and bottom with truncated triangular portions 16 and 18 separated by a gap 20. With this arrangement, the electric field induced by the microwave energy flowing through the wave guide 10 will be concentrated across the gap 20 between the ends of the truncated triangular portions 16 and 18.

Provided in the iris plate 12 is a hole or bore 22 typically having a diameter of about 50 mils. The upper end of the bore 22, which terminates at the top of the truncated triangular extension 18, receives the lower end of a capillary 24 extending downwardly from a capsule 26 charged with a halogen gas, such as chlorine. As will be explained hereinafter, the capsule 26 and its communicating, integral capillary 24 are preferably formed from quartz. The upper end wall 28 of the capsule is provided on its undersurface and within the interior of the capsule 26 with a layer of titanium or yttrium having tritium adsorbed therein. With this arrangement, tritium will radiate beta rays (i.e., electrons) into the halogen gas within the capsule 26 to act as a priming source of electrons to facilitate rapid microwave breakdown of the gas.

When a pulse of microwave energy above a predetermined amplitude reaches the iris plate 12, the gas within the capsule 26 will ionize, the electron density representing an increase in permittivity between the triangular portions 16 and 18. This changes the capacitance of the resonant element and detunes the

circuit with the result that the wave energy is reflected. On the other hand, a pulse of microwave energy below the aforesaid predetermined amplitude will not ionize the gas and will pass through the iris plate 12.

The details of the capsule 26 and its integral, capillary portion 24 are shown in FIG. 2. The capillary is connected to an upper cup-shaped portion 30, fitted with a cover plate comprising the end wall 28. Preferably, the capsule is formed from quartz as is the cover plate 28. Deposited on the undersurface of the cover plate 28 by vacuum-deposition techniques is a thin film 32 of titanium or yttrium. This typically has a thickness in the range of about 7,000 to 12,000 Angstrom units. Following deposition of the titanium or yttrium, molecular tritium is adsorbed into the film at relatively high temperatures, on the order of 400°C. A layer of titanium dioxide or yttrium oxide 34 is formed on the undersurface of the layer 32 by aging in an oxygen atmosphere. Finally, a layer of silicon dioxide 36, having a thickness in the range of about 1,000 to 3,000 Angstrom units, is deposited over the metal-oxide surface. The deposition is typically performed by thermal evaporation of silicon monoxide in the vicinity of the metal-oxide surface in a low pressure oxygen ambient of about 10^{-4} torr.

The silicon dioxide layer 36 is deposited to a thickness which is less than the range of the tritium beta radiation in silica, thereby allowing an appreciable portion of the beta radiation to enter the discharge volume, yet preventing surface desorption and subsequent release of tritium molecules or atoms into the discharge volume. The maximum range of 10 KEV beta radiation is 0.2 mg/cm², as measured for aluminum adsorbers. This result is applicable to silica. For a range of 0.2 mg/cm² in silica, a silica thickness of 8,000 Angstrom units is required to stop the beta radiation. Accordingly, the thickness of the layer 36 must be less than 8,000 Angstrom units.

The halogen gas within the capsule 26, preferably chlorine, is filled at a pressure of about 10 torr. In certain circumstances, the smaller truncated triangular portion 16 can be either eliminated or increased to the same size as the other truncated portion 18, depending upon the application. The loaded Q is typically 4 to 7. The ejected betas from the tritium cannot penetrate a surface more than a mil or two thick and, therefore, the device is safe to handle. The silicon dioxide layer 36 acts to prevent any chemical reaction between the tritium host metal and the neutral chlorine. Negligible ionization will occur in the vicinity of the beta emitter, so that sputtering of the silica layer by positive ions will not occur.

A typical use of the device of FIGS. 1 and 2 is shown in FIG. 3. A radar transmitter 38 is connected through a circulator 40 to an antenna 42. The antenna 42, in turn, is connected through the same circulator 40 to a dummy load 44 and through a multistage receiver pro-

teCTOR 46 to a radar receiver 48. The multistage protector 46 includes three stages A, B and C, each of which includes a gaseous discharge device such as that shown in FIGS. 1 and 2. The first stage A is designed to handle megawatts, the second stage B is designed to handle tens of watts and the third or last stage C is designed to handle milliwatts.

Pulses transmitted from the transmitter 38 will have a magnitude of about 1 megawatt. Some of this energy may be reflected from the antenna 42 before transmission and have a magnitude of about 8 to 80 kilowatts. These, therefore, will trigger one or more of the gaseous discharge devices within the protector 46 and cause the energy in the range of about 8 to 80 kilowatts to be reflected to the dummy load 44. Echoes from a distant target received by the antenna 42, however, will have a magnitude in the range of about 10^{-12} to 10^{-14} watts. These will not ionize the gas in the keepalive stages and, consequently, will pass through to the receiver.

Although the invention has been shown in connection with a certain specific embodiment, it will be readily apparent to those skilled in the art that various changes in form and arrangement of parts may be made to suit requirements without departing from the spirit and scope of the invention.

We claim as our invention:

1. In a gaseous discharge device, a capsule, an ionizable gas within said capsule, and a material selected from the group consisting of titanium and yttrium having adsorbed therein tritium providing a source of primary radiation for said discharge device.

2. The gaseous discharge device of claim 1 wherein said capsule is formed from quartz.

3. The gaseous discharge device of claim 2 wherein said material selected from the group consisting of titanium and yttrium is deposited on an interior surface of said quartz capsule, and a layer of silicon dioxide covering said material selected from the group consisting of titanium and yttrium.

4. The gaseous discharge device of claim 3 wherein said layer of material selected from the group consisting of titanium and yttrium has a thickness in the range of about 7,000 to 12,000 Angstrom units and said layer of silicon dioxide has a thickness in the range of about 1,000 to 3,000 Angstrom units.

5. The gaseous discharge device of claim 1 wherein said ionizable gas is a halogen.

6. The gaseous discharge device of claim 5 wherein said ionizable gas comprises chlorine.

7. The gaseous discharge device of claim 1 wherein said capsule has an upper cup-shaped portion and a lower downwardly-extending capillary portion disposed in a gap formed by an aperture in an iris plate extending transversely across a wave guide.

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