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MICROWAVE TRANSMISSION GASEOUS DISCHARGE CONTROL DEVICE HAVING GAS RESERVOIR

Filed Nov. 23, 1960

FIG. 1

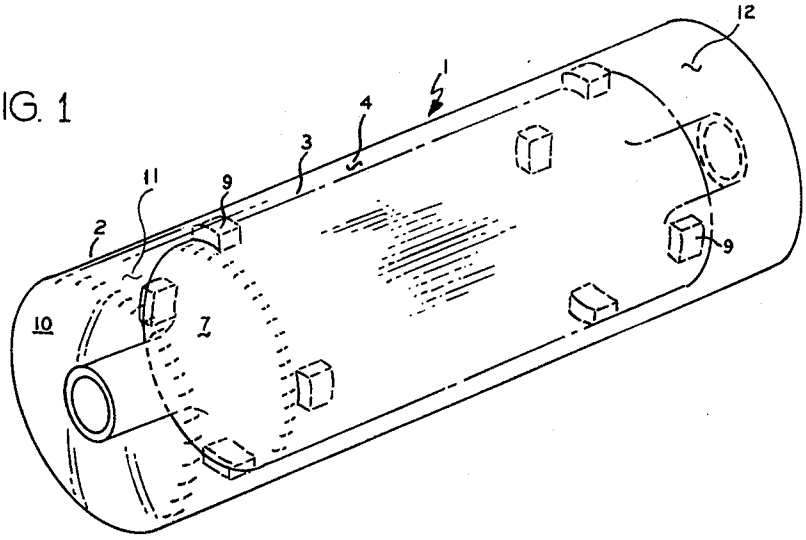


FIG. 2

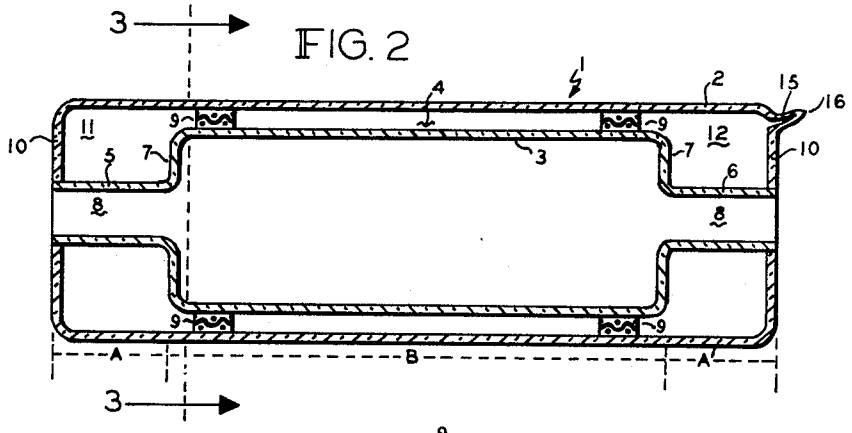
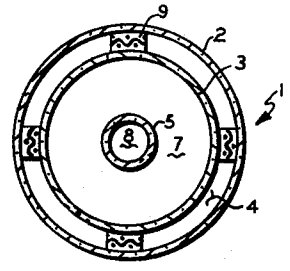


FIG. 3



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MICROWAVE TRANSMISSION GASEOUS DISCHARGE CONTROL DEVICE HAVING GAS RESERVOIR

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The present invention relates to ultra high frequency microwave transmission control devices and specifically describes an improved device of the folded cylinder type, disclosed in U.S. Patent 2,922,124, issued January 19, 1960, to Ray S. Braden and assigned to the assignee of the present invention.

The folded cylinder gaseous discharge tube disclosed in the aforementioned reference comprises a plurality of tubular dielectric members joined together at their outer ends to provide a double-walled envelope with the spacing between the walls being considered the critical component. A large axial passageway is defined along the common axis of the tubular members to facilitate passage of a coolant for the removal of heat generated by the intense gaseous discharge. With the continuing advancement of the state of the art in high power microwave transmitters, the folded cylinder discharge tube has received wide acceptance.

A difficulty encountered with the transmit receive folded cylinder gaseous discharge tubes of Braden was that when these tubes were operated at very high incident microwave power levels, the inert gaseous atmosphere contained within the annular discharge gap was degraded over a period of time so that the number of gaseous species effectively available to trigger the gaseous discharge were substantially reduced. As a consequency of this inexplicable degradative process, tube recovery times were encountered which were not only much shorter than those encountered in the pre-Braden art, but also disadvantageously shorter than recovery times desirable in a Braden device after the transmit-receive tube had operated at high power levels for long periods of time. Indeed, recovery times of the transmit-receive tubes ultimately become so short as to be comparable to the time that the transmitter was on, that is, of the order of the transmitter pulse length or duration so that it became necessary to supply additional microwave power to the transmit-receive tube in order to prevent deionization during the time the transmitter pulse was applied to the Braden device. By supplying additional microwave power in order to maintain the ionization, arc loss was substantially increased with the result that eventually destructive burn-out of the Braden tube occurred as in the pre-Braden art. The operational lifetime of the Braden devices was consequently limited thereby and there appeared to be no solution consistent with the Braden teaching which would overcome this insurmountable difficulty. Applicant has solved this perplexing problem by providing a folded cylinder having the requisite narrow gap exposed to the high power electromagnetic energy and an enlarged reservoir disposed adjacent to the ends of the envelope, which cylinder is disposed as taught by Braden in FIGS. 2, 7 and 8, for example, so that it is a waveguide disposed within a central aperture of a metallic plate member transverse a waveguide.

It is an object of the present invention to provide an improved folded cylinder gaseous discharge tube having extended operational life.

It is a further object of the invention to provide an improved folded cylinder gaseous discharge tube having an integral reservoir to facilitate storage of the ionizable atmosphere.

Other objects, features and advantages will become apparent after consideration of the following detailed specification and accompanying drawings, in which:

FIG. 1 is a perspective view of the illustrative embodiment of the invention;

FIG. 2 is a longitudinal cross sectional view of the embodiment; and

FIG. 3 is a cross sectional view along the line 3—3 in FIG. 2.

Referring now to the drawings, the embodiment **1** shown in FIG. 1 comprises two concentrically disposed cylinders, **2** and **3**, defining therebetween an annular chamber **4** in the manner disclosed in the aforesaid patent. Inner cylinder **3** has a longitudinal dimension substantially shorter than outer cylinder **2** to thereby define an equidistant area A and A′ adjacent the ends thereof when mounted as shown. Hollow tubulations **5** and **6** of reduced diameter are sealed at both ends of inner cylinder **3** as at **7** by known techniques such as flowing of a dielectric material to define a passageway **8** providing access for flow of a coolant to contact the inner walls of the cylinder. Inner cylinder **3** is desirably concentrically aligned within outer cylinder **2** by means of radially disposed spacers **9** having the thickness of the requisite dimensions of the gap **4**. A material such as quartz or Refrasil tape may be selected for the spacers. The outer ends of cylinder **2** when joined to tubulations **5** and **6**, as at **10**, will define two enlarged annular chambers **11** and **12**. An exhaust tubulation **15** in seal **10** provides for filling with an ionizable atmosphere at reduced pressures and may be tipped-off as at **16**.

The disposition of the chambers **11–12** provides for centrally locating the folded cylinder annular gap area B in the electromagnetic waveguide structure as disclosed in the aforementioned patent reference. This facilitates the critical spacing in the path of the high power energy to result in the intense ionization thereby attenuating further transmission. In accordance with the teachings of the present invention there is now provided more than double the volume of the central section B for the storage of additional ionizable atmosphere. Operation of an actual embodiment of the invention has demonstrated that the improved configuration when filled with four millimeters of pure argon and operated at power levels over one megawatt will operate between 200–300 hours longer than prototype folded cylinders.

Having thus described a specific illustrative embodiment, many alternative or modified embodiments will occur to skilled artisans. It is our intention to incorporate all such alterations and modifications as fall within the spirit and scope of the invention as defined in the appended claims.

We claim:

1. A gaseous discharge switching device for control of transmission of ultra high frequency electromagnetic energy and for installation across a coupling aperture comprising inner and an outer concentrically disposed cylindrical dielectric members spaced apart to define an annular discharge gap, so that said switching device has a rapid deionization time characteristic of gaseous diffusion within said annular discharge gap for recovery thereof, hollow tubular members of reduced diameter joined to the ends of the inner member by means of a dielectric seal, said outer member being joined to the outer edges of said tubular members by a similar seal to thereby define an hermetically sealed envelope having enlarged annular chambers adjacent to each end and an ionizable gaseous atmosphere contained within said envelope under reduced pressure, said annular chambers forming separate reservoirs within which a portion of said ionizable gaseous atmosphere is stored for replenishing a portion of said gaseous atmosphere which is being ionized and degraded

within said annular discharge gap, so that said deionization time is maintained while said high frequency electromagnetic energy is ionizing said portion of said gaseous atmosphere of said switching device.

2. A gaseous discharge switching device for control of transmission of ultra high frequency electromagnetic energy and for installation across a coupling aperture comprising a first cylindrical dielectric member, a second cylindrical dielectric member of reduced diameter concentrically disposed within said first member to define therewith an annular discharge gap over the entire axial length of said second member so that said switching device has a rapid deionization time characteristic of gaseous diffusion within said annular discharge gap for recovery thereof, a hollow tubular member of still further reduced diameter joined to each end of said second member by means of a dielectric seal, the ends of said first member being joined to the outer edges of said tubular members by a similar seal to thereby define an hermetically sealed envelope having enlarged annular chambers adjacent to each end and an ionizable gaseous atmosphere contained within said envelope under reduced pressure, said annular chambers forming a separate reservoir within which a portion of said ionizable gaseous atmosphere is stored for replenishing a portion of said gaseous atmosphere which is being ionized and degraded within said annular discharge gap, so that said deionization time is maintained longer than the length of time during which said high frequency electromagnetic energy is ionizing said portion of said gaseous atmosphere of said switching device.

3. A gaseous discharge switching device for control of transmission of ultra-high electromagnetic frequency and for installation across a coupling aperture comprising an outer cylindrical dielectric member and an inner cylindrical dielectric member being concentrically disposed in relation to said outer member and spaced apart therefrom so as to define an annular discharge gap therebetween, said inner member having a hollow tubular member of reduced diameter being joined to the one end thereof and forming a dielectric seal therewith, said outer member being joined to the outer edges of said reduced diameter tubular member and forming a dielectric seal therewith for providing an axial passageway for passing a coolant through said reduced diameter tubular member into and through the hollow interior of said inner dielectric member, said inner and outer members forming a hermetically sealed envelope having a reservoir adjacent to said one end of said inner member through which said reduced diameter tubular member passes axially therethrough, said envelope containing an ionizable gaseous atmosphere which is stored in said reservoir without being ionized therein and is ionized and degraded within said annular discharge gap, said gaseous discharge switching device having a rapid recovery time characteristic of gaseous diffusion within said annular discharge gap for deionization thereof characterized in that said recovery time is maintained at a value in excess of the length of time during which high power electromagnetic energy ionizes said gaseous atmosphere within said annular discharge gap.

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