Jan. 19, 1960 R. S. BRADEN 2,922,131

FOLDED CYLINDER GASEOUS DISCHARGE DEVICE

Filed Oct. 8, 1958 2 Sheets-Sheet 1

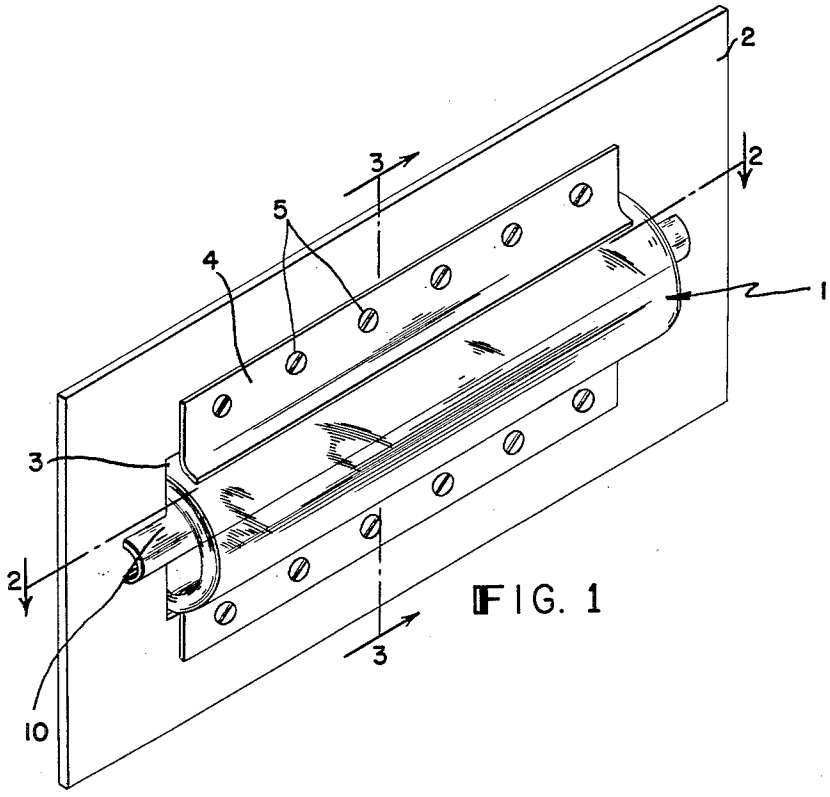


FIG. 1

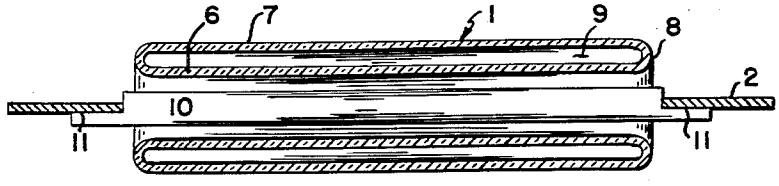


FIG. 2

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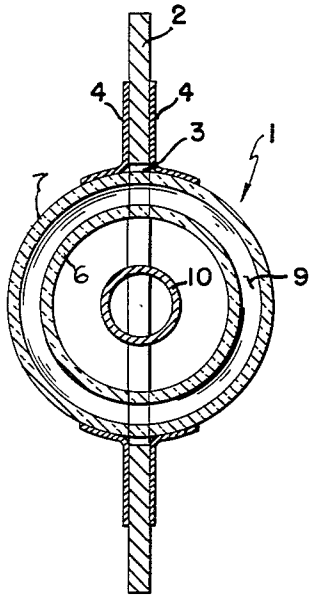


FIG. 3

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FOLDED CYLINDER GASEOUS DISCHARGE DEVICE

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Application October 8, 1958, Serial No. 766,088

2 Claims. (Cl. 333—98)

The present invention relates to microwave energy transmission control devices of the gaseous discharge type and in particular to an improved electrodeless tubular energy sensitive device of the folded cylinder type.

The control of microwave frequency transmission has resulted in many types of gaseous discharge switching devices for use in single antenna radar systems. By means of intense ionization of a gaseous atmosphere within an evacuated enclosure high power electromagnetic energy is prevented from damaging the sensitive receiver apparatus. A new concept in such devices is disclosed in copending application of Ray S. Braden, Serial Number 663,538, dated June 4, 1957. The folded cylinder disclosed therein comprises a tubular member formed by two concentric cylinders of a dielectric material sealed at their ends to define an annular chamber. The chamber is evacuated and filled with an ionizable atmosphere selected from the noble gases. The electrical parameters of the folded cylinder are unique in that extremely high transmitter powers may be handled by a relatively thin sheath of an ionized gas disposed within the transmission path. The spacing of the cylinder walls is critical and determines to a considerable extent the recovery time characteristic which must be desirably of short duration for efficient switching performance.

The folded cylinder may be mounted in combination with any suitable waveguide structure for use as a pre-TR, anti-TR, TR or crystal protector device. In the various methods of mounting, the device will be positioned in either a branched line, flush with a wall of the main transmission line, or directly across the transmission path. The electric field configurations at high power levels in these various mounting positions apparently result in certain regions of varying plasma density along the cylinder envelope. These regions are particularly evident as dark and light striations during ionization. Further, since the folded cylinder is generally mounted in adjacent metallic supporting structure variable sparking may occur during the high power levels incident on the cylinder.

The present invention, therefore, has for its primary object the provision of an improved gaseous discharge device of the folded cylinder type in which the electric field across the device is stabilized to thereby eliminate the formation of striae during ionization of the gas.

A further object is to provide an improved gaseous discharge device of the folded cylinder type capable of being mounted in any desired position in suitable waveguide structure for switching of high transmitter power levels without degradation of electrical characteristics.

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

Fig. 1 is a perspective view of the illustrative embodiment;

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

Fig. 3 is a vertical cross sectional view along the line 3—3 in Fig. 1.

Referring now to the drawings, the illustrative embodiment of a folded cylinder type gaseous discharge device 1 is shown mounted in a metallic plate member 2 having a centrally located rectangular opening 3 resonant at the selected operating frequency of the device or system in which it is used. Mounting members 4 of a resilient metal are secured on opposite sides of opening 3 on both sides of plate 2 by means of screws 5. It will be noted that the folded cylinder is supported wholly within the opening and extends transversely across the wide dimension of the plate 2. Other methods of mounting may be employed such as silicone rubber cement, a spring coil or serrated metallic fingers all within the realm of common knowledge in the art.

Folded cylinder 1 is fabricated in accordance with the aforementioned patent application and comprises two concentrically disposed spaced quartz or glass cylinders 6 and 7 joined together at their outer ends as at 8 to form a vacuum tight envelope. The spacing between the cylinders 6 and 7 defines an annular gap 9 to provide for storage of an ionizable gaseous atmosphere under reduced pressure. The dimensions of the gap and cylinders have been discussed in the previous disclosure and need not be included herein.

The embodiment of the invention may be mounted as shown in a metallic plate member and this member may be positioned in waveguide structure to form numerous devices. If the plate member is mounted at one end of a section of waveguide and resonant discharge gap structures disposed therein and another dielectric window at the opposite end, a TR device will result. Such a mounting of the folded cylinder will position it transversely across the guide and the full incidence of power will be realized.

In certain other applications however, the folded cylinder may be mounted in the E-plane of the waveguide transmission line with the plate member terminating at the end of a one-half wavelength section of guide. Such a mounting is referred to as a branch mounting.

Other devices that have evolved with the use of a folded cylinder include an ATR wherein a closed end quarter wavelength section of waveguide is provided with the folded cylinder. With the ATR in position the folded cylinder would be flush with the top wide wall of conventional rectangular waveguide. Further, the pre-TR incorporates two folded cylinders mounted at opposite ends of a short section of a waveguide without any resonant discharge gap element disposed internally within the guide. Such a device is conventionally positioned in the transmisison line before the TR device and, hence, receives the main burst of transmitter power during the transmission cycle.

In all of the aforementioned mounting positions the folded cylinder is disposed transversely to the electric field of the electromagnetic wave. The distribution of the field within the cylinder mounted in such a fashion results in varying plasma densities visible as striae during ionization. To overcome this variation in field distribution, a metallic rod or tubulation is axially disposed within the cylinder with the ends thereof electrically connected to the plate member. Since either a rod or tubulation will produce similar results, this metallic member will be referred to as an electric field stabilizer.

Referring to Figs. 2 and 3 the electric field stabilizer 10 is shown in the embodiment as a length of tubing of a metal such as copper. The ends of the tubing may be notched as at 11 to facilitate soldering to the plate member. The dimensions of the rod are selected as a compromise of the Q values resulting from the introduction of this metallic element across the resonant opening,

Since the metallic element lowers the Q of the overall window assembly to some extent this factor will be considered in determining the bandwidth of the devices incorporating the folded cylinder. Generally, broadband TR devices employ low Q resonant elements and the introduction of the electric field stabilizer will not materially alter the bandwidth characteristics. With the use of this structure the field distribution has been altered to eliminate the striae as well as any arcing across the plate opening. Similar results have been obtained with solid rod structures. The embodiment, shown as a hollow tubulation may, therefore, be considered as an illustrative example and not as a limitation.

What is claimed is:

1. A resonant window assembly for high power microwave transmission control devices comprising a metallic plate member defining a centrally located rectangular aperture dimensioned to be resonant at a selected frequency, a folded cylinder of a dielectric material enclosing substantially all of said resonant aperture with its axis disposed within the plane of the plate member, said folded cylinder comprising a plurality of concentrically disposed cylindrical members sealed together at their

outer ends to form an hermetically sealed envelope defining an axial passageway therethrough, an ionizable gaseous atmosphere contained within said envelope and a cylindrical metallic element axially disposed within said passageway with the ends thereof electrically connected to the plate member.

2. In combination with electromagnetic waveguide structure for propagating high power microwave frequency energy a flat metallic plate member having a centrally located resonant aperture, a tubular gaseous discharge device enclosing substantially all of said resonant aperture with its axis disposed within the plane of the plate member, said discharge device comprising plural concentrically disposed dielectric cylinders sealed together at their outer ends to form a vacuum tight envelope with a hollow axial passageway therethrough, a cylindrical metallic element extending through said passageway with the ends thereof electrically connected to the plate member to define a continuous metallic path extending transversely to the electromagnetic waves propagated in the waveguide.

No references cited.