

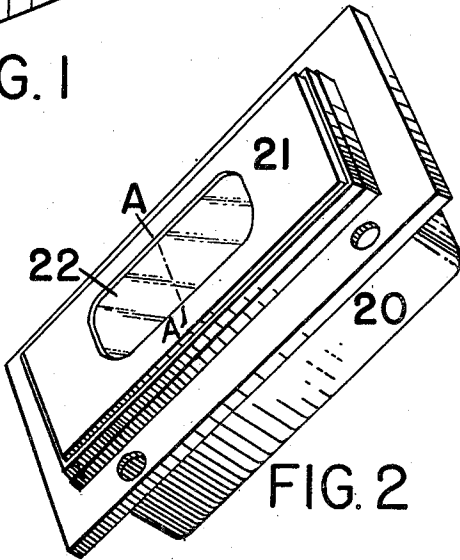
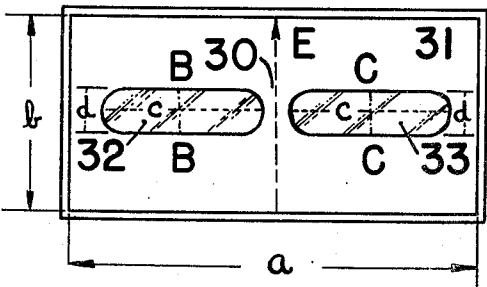
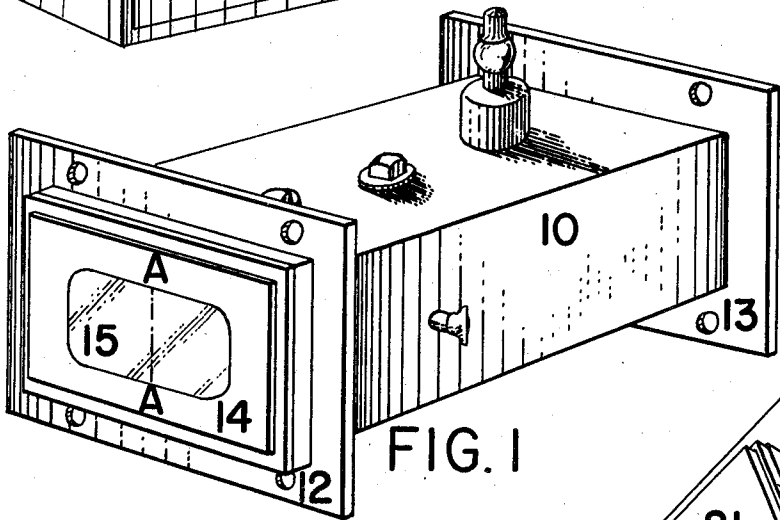
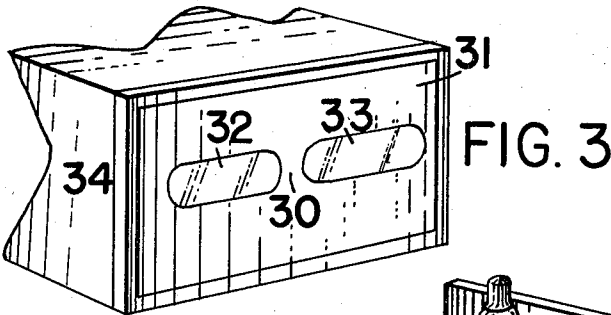
Nov. 5, 1957

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2,812,504

SHUNTED RESONANT WINDOW

Filed Nov. 17, 1954



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SHUNTED RESONANT WINDOW

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Application November 17, 1954, Serial No. 469,437

1 Claim. (Cl. 333—98)

The present invention relates to electromagnetic transmission apparatus and, more particularly, to resonant apertured window structure for use with ultra high frequency gaseous discharge devices or waveguide structure so selectively transmit electromagnetic wave energy.

In apparatus characteristically employing resonant window structure having a central aperture formed in a metallic frame which may be enclosed with a low loss dielectric material, the dimensions of the aperture are carefully selected to pass energy at a predetermined frequency. Generally, rectangular apertures are employed extending transversely across the waveguide structure with the upper and lower edges of the opening determining the capacitive susceptance of the window.

The described structure may be found in gaseous discharge devices such as the transmit-receive and anti-transmit-receive tube which function as switching devices in radar systems to permit the use of a single antenna for receiving and transmitting. In such devices, a build up of voltage potential across the resonant aperture will result in a high intensity gaseous discharge to thereby block further wave energy from passing through the tube. By altering the impedances of the waveguide structure in which they may be positioned, such tubes either isolate the sensitive receiver during transmission, as in the case of the transmit-receive or TR tube, or prevent absorption of returning signals by the transmitter, as in the case of the anti-transmit-receive or ATR tube.

Improvement in power output of present day transmitters has produced a serious problem of handling the intense heat generated by the gaseous discharge which may result in sputtering of metallic deposits onto the dielectric surface thereby upsetting electrical characteristics or in breakage of the dielectric enclosure thereby destroying the vacuum condition of the tube. A further problem exists in deionization of the discharge area after a high intensity arc, since residual electrons may attenuate the weak returning signal and thereby reduce the overall detection efficiency of the system.

It is, therefore, an object of the present invention to provide a novel resonant window structure which reduces the heat generated by a discharge without any loss in power handling ability.

A further object is to provide a resonant window for gaseous discharge switching devices capable of handling high power outputs without generation of a severe electrical arc at the point of maximum electric field intensity presented across a discontinuity in the path of electromagnetic wave energy.

A still further object of the invention is to provide a resonant window for electromagnetic wave transmission devices with greatly improved deionization time characteristics.

Briefly, my invention attains the objects enumerated above by providing a waveguide discontinuity having two substantially rectangular slots extending transversely across the electric field of an electromagnetic waveguide

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system. The improved window structure is separated by a complete conductive path at the point of maximum electric field intensity which acts as an inductive shunt susceptance. As a result, the high power pulse presented across the discontinuity cannot initiate a high intense electrical arc, but cause a dual discharge across the paired openings of considerably less intensity thereby preventing the concentration of an arc at the point of maximum field intensity. The provision of a conductive path further permits the high current to pass through the path thereby reducing the heat generated by an intense discharge.

A further advantage of my improved structure is that without an intense gaseous discharge the deionization time required to render the area of the discharge conductive for low level returning signals is greatly reduced. In a single-apertured prior art structure as higher power levels are attained the effectiveness of the gaseous discharge device is reduced because the time delay in returning the ionized atmosphere to the normalized state is greatly increased.

Further advantages and features will be apparent after consideration of the following detailed description and appended drawings, in which:

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

Fig. 2 is a perspective view of an illustrative anti-transmit-receive device;

Fig. 3 is a fragmentary view of waveguide structure incorporating the illustrative embodiment of the invention; and

Fig. 4 is an enlarged front elevation view of the illustrative embodiment.

Referring now to Fig. 1, there is shown a transmit-receive tube incorporating a resonant window element of the prior art construction. The tube envelope comprises a length of waveguide 10 of rectangular cross section with an input coupling flange 12 and output coupling flange 13 hermetically sealed to the ends thereof. Each flange is provided with a metallic plate 14 having a rectangular shaped aperture enclosed with a dielectric window 15. The dimensions of the rectangular aperture are selected to pass electromagnetic waves of a predetermined frequency through the waveguide 10 at low power levels.

For switching purposes the section of waveguide 10 is filled with an ionizable atmosphere such as argon or hydrogen with a small percentage of water vapor to a total pressure of from 5 to 10 millimeters of mercury. As the power incident upon the input end 12 reaches a predetermined level, the voltage potential across the upper and lower edges of the opening 15 will initiate a high intensity electrical arc across the narrow dimensions of the rectangular opening 15. Secondary discharges occur within the waveguide section 10 across plural resonant discharge gaps (not shown) provided therein in the manner well-known in the art until the waveguide section is wholly non-conductive. Essentially all of the transmitted waves will be reflected and diverted to another branch of the waveguide system.

Generally, electromagnetic waves of various forms or character may be propagated through waveguides. In describing the embodiment of the present invention, reference will be made particularly to the TE_{1,0} mode wave wherein the electric lines of force extend from top to bottom of the guide or transversely to the transmission path and the intensity varies sinusoidally, having the maximum field at the middle and zero at the edges. Hence, the initial intense arc is concentrated along the dotted line A—A in Fig. 1. Severe sputtering of metallic deposits or cracking of the dielectric material will occur

due to this concentration, particularly at the high power level of present day transmitters above 1000 kilowatts.

Another embodiment, employing a single resonant window element as shown in Fig. 2 is the anti-transmit-receive, or ATR tube having a waveguide section 20, desirably one-quarter wavelength in size. Enclosing one end of said waveguide is a flat rectangular metallic plate 21 with a resonant aperture 22. Concentration of the electrical discharge arc similarly exists in this structure, and the invention will be adaptable in the same manner as the TR tube.

As shown in Figs. 3 and 4, I provide a continuous metallic path 30 from top to bottom of the metallic plate 31 at the point of maximum electric field intensity. A pair of apertures 32 and 33, will thus be defined to extend transversely across waveguide structure 34 which may be either the TR or ATR waveguide section. Since the metallic path 30 presents a pure inductive-shunt susceptance to the maximum electric field component, indicated by dotted arrow E in Fig. 4, the waveguide current will pass through this path, thereby effectively preventing excess heating and sputtering at this point.

Apertures 32 and 33 may be considerably narrower to provide for two discharges across points B—B and C—C where the electric field intensity is reduced. Since the resultant breakdown at the dielectric windows will be less intense, the heat generated is considerably reduced. Further, reduction of the degree of ionization in the area of the discharge reduces the so-called recovery or deionization time of this structure compared to the single-aperture window. Some of the comparative advantages of the improved shunted double-apertured resonant window will be evident from the results shown in Table I, of measurements taken at a power level of 3000 kilowatts and a frequency of 5,200 to 5,600 megacycles.

Table I

Window Type	Recovery Time, Micro-seconds	Arc Loss (db)	Leakage Power (Milli-watts)	Body Temp. (Centi-grades)
Single Aperture.....	9.0	.46	28	75
Shunted Aperture.....	7.5	.18	28	60

The dimensions of the window apertures are generally determined by experimentation, since such factors as

varying dielectric material dimensions must be considered. It is, therefore, impossible to rely on theoretical computations completely and final adjustments to tune the window to the desired frequency are made by grinding the dielectric material.

As a result of constructing various models of the illustrative embodiment on which the foregoing electrical measurements were recorded, the following dimensions were obtained. In a rectangular waveguide structure having a wide wall internal dimension "a" of 1.875 inches and narrow wall "b" of .875 inch, a conductive metal path 30 of .030 inch produced the optimum results. The apertures 32 and 33 had a width "c" of .830 inch and height "d" of .200 inch.

There has thus been disclosed an efficient resonant window structure for wave transmission devices operating at high power levels. The heat generated by the discharge across my improved structure is considerably reduced and tubes employing such structure have demonstrated desirable results over long periods of operation at power levels in excess of 1000 kilowatts.

While I have described a specific embodiment of the invention, various modifications will occur to those skilled in the art. It is, therefore, my intent to cover in the appended claim such alterations or modifications as fall within the scope of the invention.

What is claimed is:

In combination with a section of rectangular waveguide adapted for propagation of electromagnetic energy in the TE_{1,0} mode a resonant window element comprising a metallic plate member having a pair of apertures therein sealed by a dielectric material, said apertures extending in spaced coplanar relationship along the longitudinal axis of said plate member and defining therebetween a continuous metallic path between the top and bottom broad walls of said waveguide section at the point of maximum electric field intensity of the electromagnetic energy propagated through said waveguide section.

References Cited in the file of this patent

UNITED STATES PATENTS

2,567,701	Fiske	Sept. 11, 1951
2,668,276	Schooley	Feb. 2, 1954
2,682,641	Sensiper	June 29, 1954
2,684,469	Sensiper	July 20, 1954
2,748,351	Varnevin	May 29, 1956