

May 13, 1958

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2,834,949

ROTATABLE RESONANT IRIS

Filed Feb. 18, 1955

3 Sheets-Sheet 1

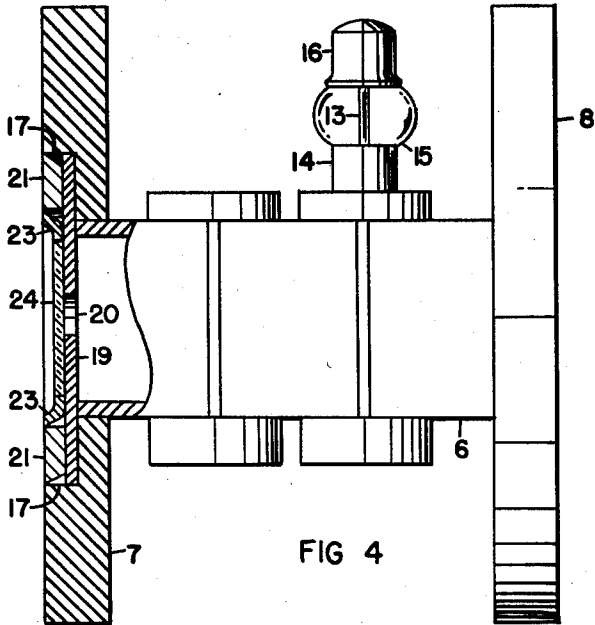


FIG 4

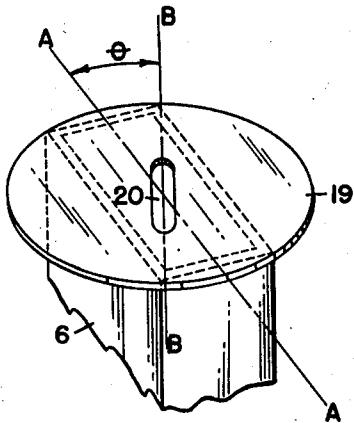


FIG 5

PRIOR ART
RESONANT WINDOW

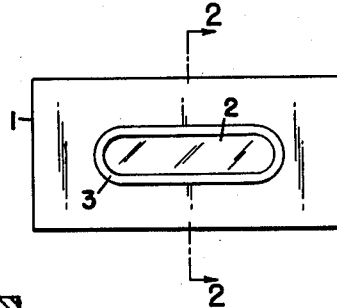


FIG 1

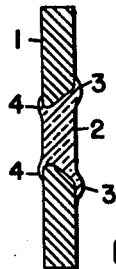


FIG 2

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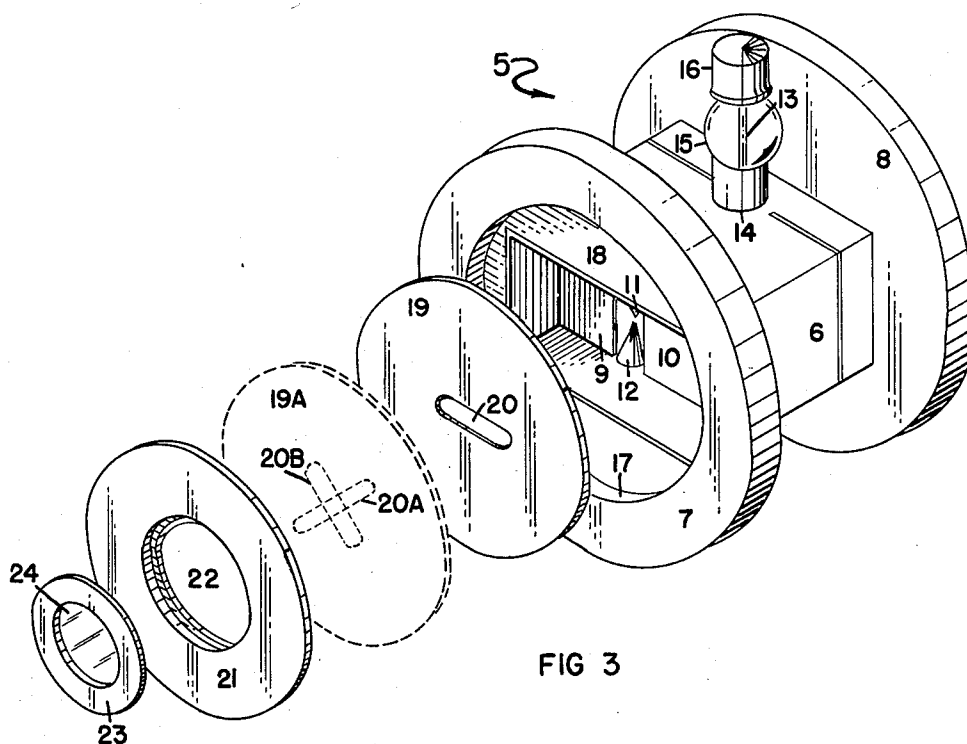
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3 Sheets-Sheet 2



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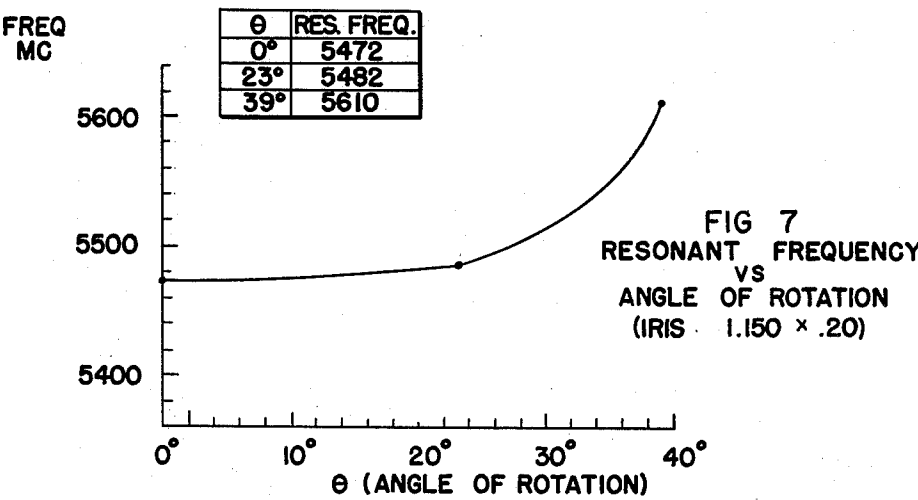
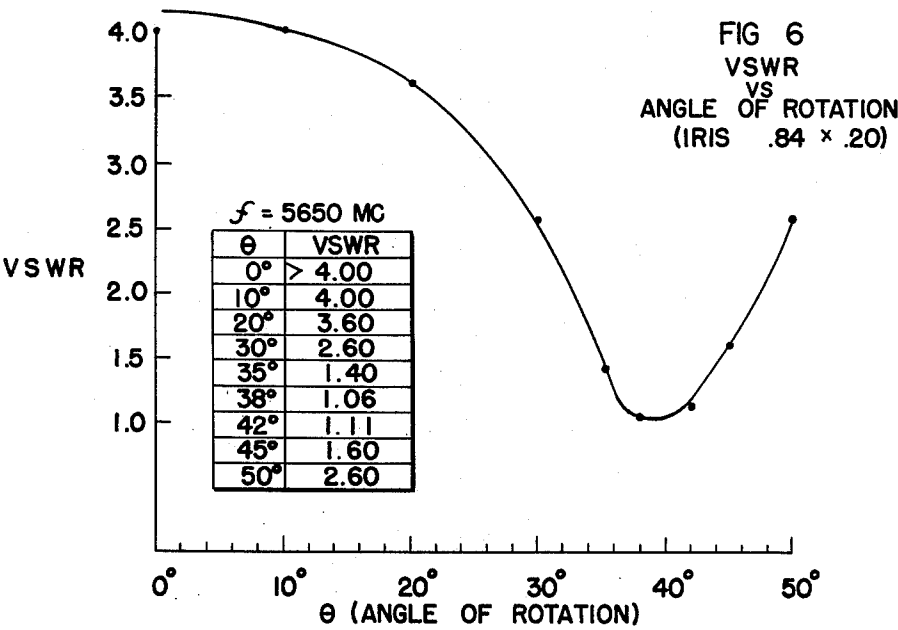
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ROTATABLE RESONANT IRIS

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3 Sheets-Sheet 3



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2,834,949

ROTATABLE RESONANT IRIS

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1 Claim. (Cl. 333—98)

The present invention relates to microwave transmission apparatus and, more particularly, to an improved resonant window employed in such apparatus for tuning to a specific frequency or band of frequencies and an improved method of manufacturing such windows.

Various embodiments in the microwave tube art employ resonant structures either in coupling the energy into or out of the device. Since such devices generally employ vacuum tight enclosures and may be filled with ionizable atmospheres to provide for a gaseous discharge, it is necessary to cover such resonant members with a hermetically sealed dielectric material, such as glass or ceramic, depending on the power level to be handled.

Examples of devices including the structure to be described are transmit-receive and anti-transmit receive tubes, klystrons, and magnetrons. The invention will be specifically described in conjunction with one of these devices, namely the transmit-receive gaseous discharge switching tube. Prior art construction of resonant dielectric-covered windows is described in the text "Microwave Duplexers" by Smullin and Montgomery, Radiation Laboratories Series, McGraw-Hill Book Company, New York (1948), at pages 102-106 inclusive. It will be evident after consideration of the present invention that it may be practiced in other embodiments with similar results.

Prior art transmit-receive switching tubes commonly employ a rectangular or elliptical iris window member as a resonant element, on the input and output end of the tube envelope. The member is generally mounted transversely in the path of electromagnetic waves with the long dimension of the opening extending parallel to the wide wall of the waveguide. The resonant frequency is determined originally by the height of the opening as well as the distance along the periphery thereof, and the dimensions must be controlled to very close tolerances. Where a dielectric covering material is required, the thickness and dielectric constant of such material are critical values in the determination of the resonant frequency.

Inasmuch as the thickness of the dielectric material may change appreciably during the window sealing process when the material is in a viscous state, careful control of temperature and oven time is necessary. Resonant windows fabricated according to the prior art techniques often times require grinding after assembly to restore the resonant frequency condition. An example of prior art structure is shown in U. S. Patent 2,419,049 issued April 15, 1947.

The present invention has, therefore, for its primary object the provision of a resonant window structure for microwave transmission devices that is easily assembled and provides for accurate tuning to the desired frequency without careful control of the mechanical dimensions prior to window sealing.

A further object is to provide an improved resonant window structure for such devices which is easily adapt-

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able to any type of covering material without any change in the mechanical dimensions of the window opening.

It is a still further object to provide a simplified and inexpensive method of fabricating such resonant windows.

Briefly, the invention comprises a combination of a metal disc, having a diameter in excess of the dimensions of the wide waveguide wall, with a rectangular centrally positioned iris therein and an outer frame member of circular configuration with a circular dielectric member positioned therein. Tuning of the window structure is achieved simply by rotation of the metal disc to the desired frequency. Experimental data has shown that the greater the angular displacement of the opening from a transverse position, the higher the resonant frequency. After positioning of the first sample of any selected material, the iris may be rotated to compensate for the dielectric constant of the material. There is thus provided a tunable resonant window whose iris dimensions may be approximated with the final tuning adjustment being made by rotation of the iris. Subsequent windows may be fabricated to a predetermined angular setting of the iris and any difficulties arising from prior art sealing methods are eliminated.

The invention offers a distinct advantage in that any changes in the operating frequency of the selected device may be made very simply and inexpensively. Such changes could only be accomplished with prior art windows by discarding the fabricated frame members and redesigning a completely new structure. Further, the critical resonant windows may now be fabricated by average skilled electronic workers rather than highly skilled workers formerly required thereby reducing the overall cost of this component.

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

Fig. 1 is a front elevation of an embodiment of prior art window construction;

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

Fig. 3 is an exploded perspective view of the illustrative embodiment of the present invention;

Fig. 4 is a side elevation of the illustrative embodiment, partly in section;

Fig. 5 is a diagrammatic presentation of the iris structure of the invention and associated waveguide illustrating the principle of the invention;

Figs. 6 and 7 are curves illustrating results measured with various embodiments of the invention.

Referring now to Figs. 1 and 2 there is shown a resonant window of prior art construction having a metallic frame member 1 of approximately the same dimensions as the selected waveguide section to which the window is hermetically sealed at an end thereof. A centrally positioned substantially rectangular opening is enclosed with a dielectric material 2 hermetically sealed to frame 1 by means of conventional glass-to-metal sealing techniques. The commercial alloy Kovar consisting of nickel, cobalt, and iron, is generally employed because its coefficient of expansion is very near the value of desired sealing dielectric material. The point of seal contains a mixture of metallic oxides and dielectric material and is indicated at 3 and 4.

Referring now to Figs. 3 and 4, the illustrative embodiment shown is a transmit-receive tube 5 of the type adapted to pass a selected band of frequencies comprising a section of rectangular waveguide 6 having hermetically sealed at the ends thereof a circular input flange 7 and output flange 8. Disposed within waveguide 6 at intervals of approximately a quarter of a wavelength are metal plates 9 and 10 and conical electrodes 11 and 12 defining resonant discharge gap structure well-known in

the art. An ignitor or keep-alive electrode 13 extends into the device through the top wall of waveguide section 6 and is supported by a collar 14, glass bead 15, with a terminal cap 16, for external circuit connection.

The embodiment of the invention will be shown in connection with one of the flanges of the tube, namely input flange 7. It may be noted, however, that the invention may be practiced on either the input or output end or both.

I first provide an annular recess 17 in input flange 7 exposing an internal flat wall section 18 having a diameter larger than the widest guide wall. A thin, flat, circular disc 19 is fabricated from either Kovar or brass to provide a substantially close fit within recess 17 and a centrally positioned rectangular iris opening 20 is provided therein. The disc is positioned against wall 18 during assembly of the tube and may be rotated to the position at which the required resonant frequency is measured by means of conventional test apparatus. As shown in Fig. 3 the reference numeral 19A shows in dotted lines possible positions of said disc with the iris shown at 20A or 20B for illustrative purposes.

Fig. 5 illustrates very simply the principle of the invention. As shown, the circular disc 19 has an overall diameter in excess of the widest dimension of the waveguide section 6. A transverse line A—A indicates the original position of the iris prior to rotation. Line B—B indicates a possible position at which the resonant iris will be resonant at the selected frequency. The angle symbol θ may be recorded on the first production samples and subsequent tubes may be manufactured very simply by placing the iris structure in this position.

After the frequency setting has been made by rotation of iris member 19, it may be soldered or brazed to the inner walls of recess 17 and wall 18 to maintain this member in the resonant position. An outer frame member 21 provided with an opening 22, is dimensioned to provide a relatively close fit against the walls of recess 17. This member may be fabricated from steel and may be copper plated to facilitate brazing to the input flange 7 to hermetically seal this member to the tube envelope. A window frame 23 provided with a disc 24 of the desired covering material such as glass or ceramic is next sealed into the opening 22 by ordinary metal-to-metal brazing techniques.

The invention is particularly well suited to the use of a ceramic material for tubes employed in extremely high power applications and the conventional ceramic-to-metal sealing techniques are employed, such as coating the members to be joined with a titanium hydride, copper powder or molybdenum-manganese powder with a suitable binder and then heating in a hydrogen furnace to complete the seal.

Data obtained from several embodiments of the invention are plotted in Figs. 6 and 7 to indicate the effect

of rotation of iris member 19 on the important electrical characteristics such as voltage standing wave ratio and resonant frequency.

In Fig. 6 on iris opening approximately, .85 inch in length and .20 inch in height at a frequency of 5650 megacycles resulted in a VSWR of 1.06 at a 38° angular displacement. There is thus shown an indication of one advantage of the invention in processing resonant window assemblies. A fixed frequency is employed and by rotation the point of lowest VSWR is obtained. Subsequent assemblies could be automatically set at the optimum angular displacement.

Fig. 7 illustrates the results obtained in adjusting the frequency by increasing the angle of deviation. This tested embodiment employed an iris dimension slightly larger than that in Fig. 6 to illustrate the versatility of my structure.

It is possible, therefore, to tune a window assembly accurately by merely adjusting the angular displacement of the iris member. It will be evident that the disclosed structure has numerous applications in the field of microwave transmission. The foregoing description of a specific embodiment is considered to be merely illustrative and I intend to cover in the appended claim any changes or modifications which fall within the scope and spirit of the invention.

What is claimed is:

A resonant window structure for hermetically sealing an open end of a waveguide envelope for microwave transmission devices comprising a circular flange member secured to and encircling a section of rectangular waveguide, said flange member having a circular recessed portion with a depth sufficient to expose the end of said waveguide, a metallic plate member having a central iris opening positioned within said recessed portion and contacting said waveguide end, said plate member being rotatable about its center to thereby angularly displace said iris opening with respect to the longitudinal axis of said waveguide, and an outer frame member having a central dielectric covered aperture positioned in contiguous relationship against said plate member, the overall structure being retained within said recessed portion without extending beyond the outer face of said flange member.

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