July 7, 1959 W. S. GEISLER, JR 2,894,228

RADIO FREQUENCY WINDOW

Filed Nov. 2, 1953 3 Sheets-Sheet 1

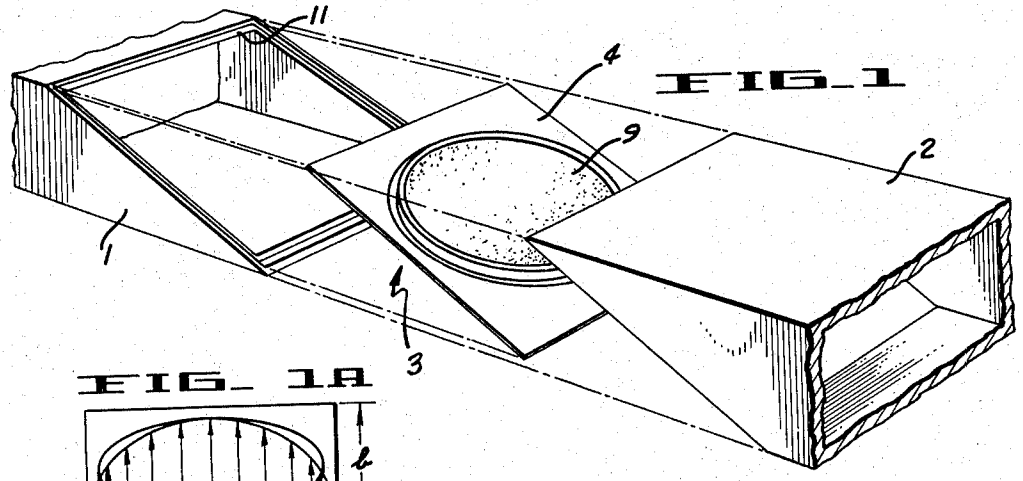
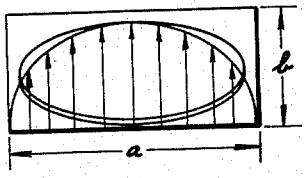



FIG_1

FIG_1A



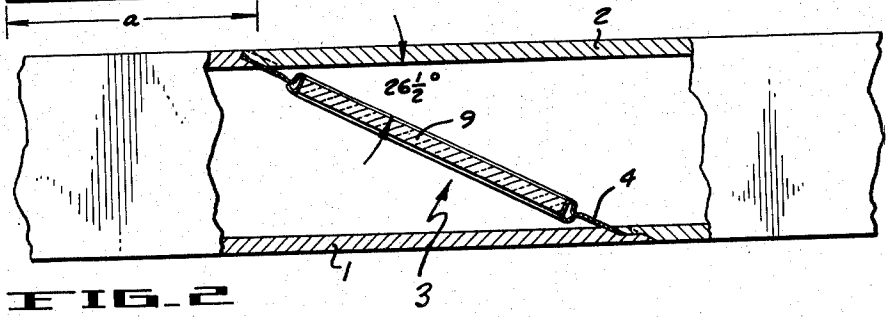




FIG_2

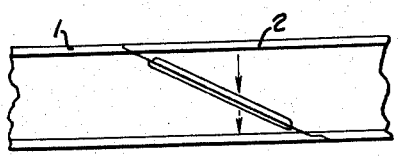



FIG_3

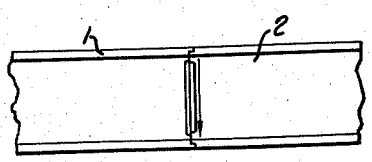



FIG_4

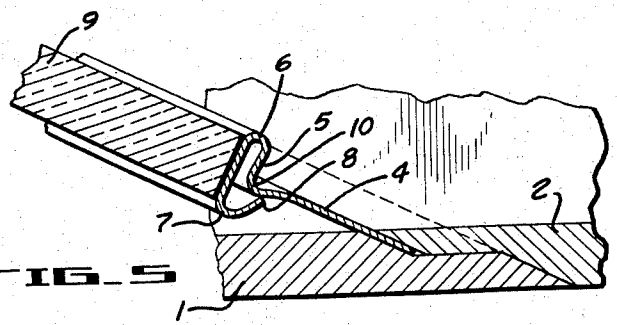



FIG_5

INVENTOR
WILSON S. GEISLER, JR.
BY Paul B. Hunter
ATTORNEY

July 7, 1959 W. S. GEISLER, JR 2,894,228

RADIO FREQUENCY WINDOW

Filed Nov. 2, 1953 3 Sheets-Sheet 2

FIG. 6

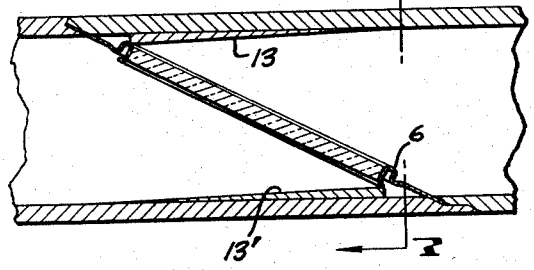
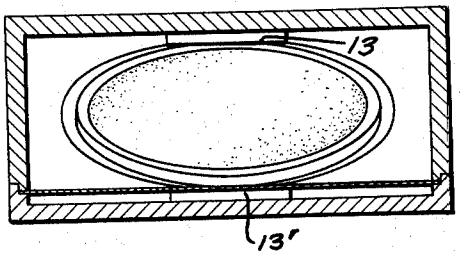



FIG. 7



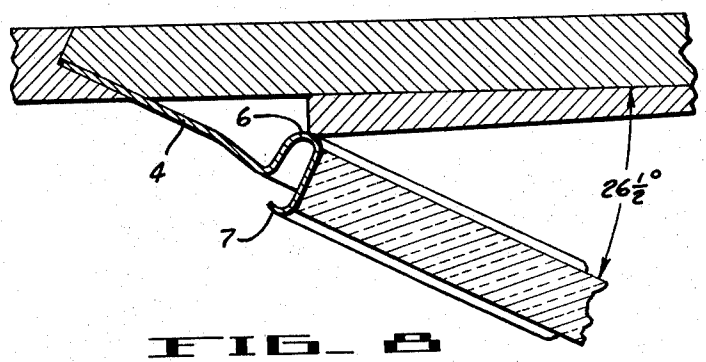




FIG. 8

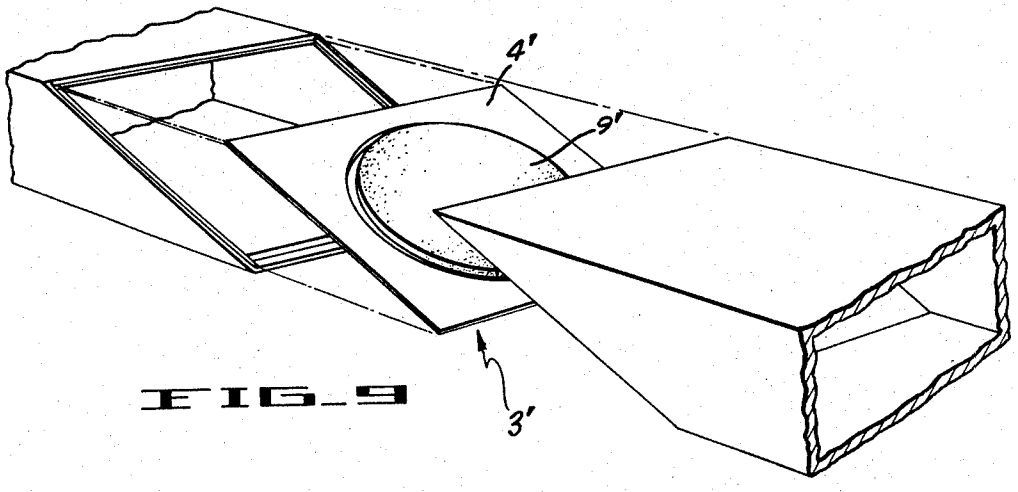



FIG. 9

INVENTOR
WILSON S. GEISLER, JR
BY Paul B. Hunter
ATTORNEY

July 7, 1959 W. S. GEISLER, JR 2,894,228

RADIO FREQUENCY WINDOW

Filed Nov. 2, 1953 3 Sheets-Sheet 3

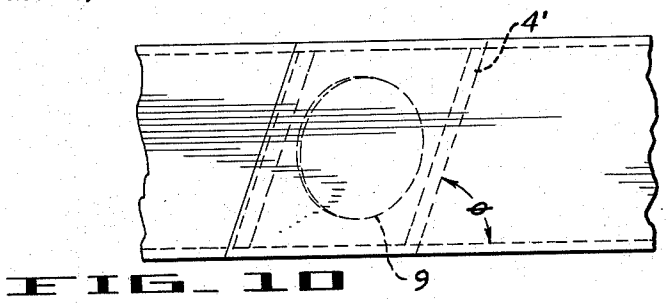



FIG_10

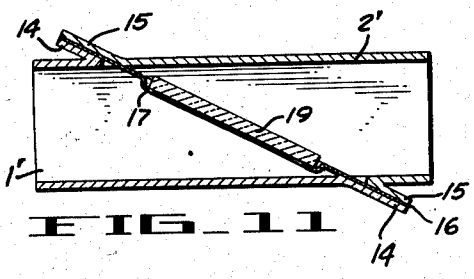



FIG_11

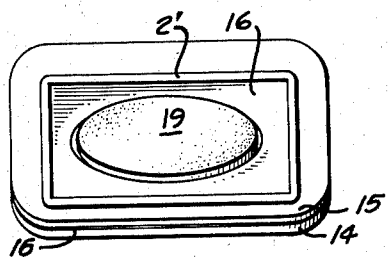



FIG_12

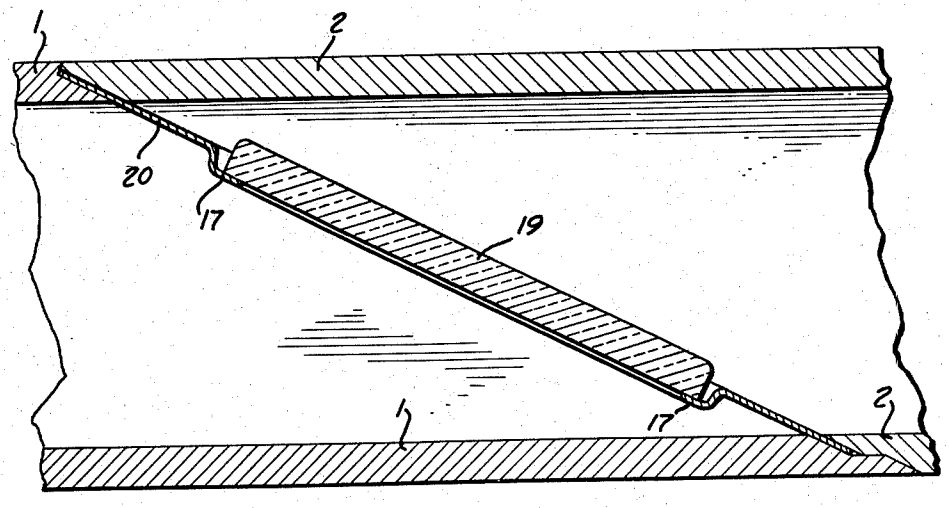



FIG_13

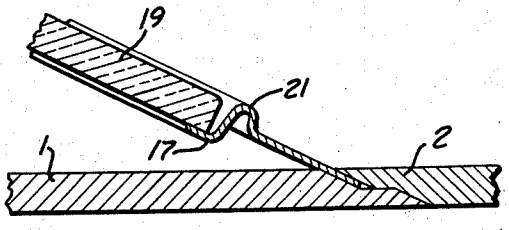



FIG_14

INVENTOR.
WILSON S. GEISLER, JR.
BY Paul B. Hunter
ATTORNEY

United States Patent Office 2,894,228 Patented July 7, 1959



2,894,228

# RADIO FREQUENCY WINDOW

Wilson S. Geisler, Jr., Atherton, Calif., assignor to Varian Associates, San Carlos, Calif., a corporation of California

Application November 2, 1953, Serial No. 389,568

6 Claims. (Cl. 333—98)

This invention relates, generally, to radio frequency windows and the invention has reference, more particularly, to a novel radio frequency sealing window for radio frequency generators including microwave generators.

Heretofore considerable difficulty has been experienced with radio frequency windows used in waveguides for maintaining the vacuum in a microwave radio frequency generator for various reasons among which may be mentioned; firstly, windows as heretofore constructed generally were limited in power rating and either tended to lose vacuum due to unequal thermal expansion and contraction of the window and associated waveguide or tended to break down due to shorting across the window surface under the transmission of higher powers; secondly, most windows as heretofore constructed did not properly match the waveguides in which they were used so that losses were created by the use of the window resulting in standing waves and other undesirable phenomena; thirdly, windows as heretofore constructed often had to employ an external tuning iris and this also limited the power transmitted and at the same time also usually lowered the breakdown potential.

The principal object of the present invention is to provide a novel radio frequency window for use in waveguides for sealing off radio frequency apparatus, including microwave generators, amplifiers and other equipment, said window being so constructed and arranged as to possess extremely high potential breakdown values and inherent matching qualities so that the same matches the guide in which it is used substantially eliminating standing waves and other undesirable phenomena.

Another object of the present invention is to provide a novel radio frequency window comprising a flexible metal frame member fixed within the guide and carrying a dielectric window therewithin, said frame member and window being canted with respect to the longitudinal axis of the guide at such angle as to reduce any reflections set up by the window to a minimum and at the same time greatly enhancing the breakdown potential of the window.

Still another object of the present invention is to provide a waveguide window that is of simple construction and easily manufactured and one which is of wide band owing to the use of a circular dielectric diaphragm extending substantially completely across the guide, the window being so constructed as to allow for relative thermal expansion and contraction of the frame member and diaphragm to eliminate the relative separation of these members and resultant loss of vacuum.

Other objects and advantages of this invention will become apparent from the specification, taken in connection with the accompanying drawings wherein the invention is embodied in concrete form.

In the drawings:

Fig. 1 is a perspective view illustrating one form of the novel window of this invention and the manner of assembling the same in a waveguide,

Fig. 1A is a diagrammatic view illustrating the position of the window with respect to the dominant mode of transmission within the guide,

Fig. 2 is a side elevation with parts broken away showing the window mounted in the wageguide,

Figs. 3 and 4 are schematic views illustrating the advantages of the window of this invention in preventing breakdown within the guide,

Fig. 5 is an enlarged fragmentary view of a portion of the structure of Fig. 2,

Fig. 6 is a longitudinal sectional view of a somewhat modified construction for enhancing the matching of the window to the guide,

Fig. 7 is a sectional view taken along line 7—7 of Fig. 6,

Fig. 8 is an enlarged fragmentary view of a portion of the structure shown in Fig. 6,

Fig. 9 is a view similar to Fig. 1 of a somewhat modified construction wherein the window is not only inclined longitudinally with respect to the waveguide but is also canted transversely therein to improve the matching of the window to the guide,

Fig. 10 is a plan view of the structure shown in Fig. 9,

Fig. 11 is a longitudinal sectional view showing a somewhat modified construction,

Fig. 12 is an end view of the structure shown in Fig. 11,

Fig. 13 is a longitudinal section view of another modified construction, and

Fig. 14 is a fragmentary view of still another modification.

Similar characters of reference are used in the above figures to designate corresponding parts.

Referring now to Figs. 1, 2 and 5 of the drawings, there is shown one form of the novel window of the present invention wherein waveguide sections **1** and **2** (shown separated in Fig. 1) are adapted to have the window **3** confined therebetween. Window **3** is shown as consisting of substantially square metal frame member **4** made of copper or other suitable bendable and flexible metal having a central opening, the periphery of which is defined as particularly shown in Fig. 5 with a hollow flange member **5** having folds at **10** and **6** to provide flexibility to the flange and a third fold as provided at **7**. The flange member **5** with folds **6**, **7** and **10** are preferably pressed out of the frame member **4**, the free edge **8** of the flange member being shown abutting but not being attached to the body of the frame member **4**. The window **9** of circular shape is preferably made of ceramic and is attached in a vacuum-tight manner as by a moly-manganese joint to the flange **5**. This joint may be formed by painting the peripheral edge of disc **9** with moly-manganese and then soldering. The window **9** is of circular shape and lies in the plane of the frame **4** which is inclined to the axis of the waveguide when assembled therein, the inclination being such as to substantially eliminate reflections due to the presence of the window within the guide. Tests have shown that when the angle between the waveguide transverse wall *a* and the window is of the order of 26½° (as shown in Fig. 2) eminently satisfactory results are obtained.

The waveguide section **1** is chamfered or milled out to provide a shoulder or seat **11** against which the frame member **4** seats (as also shown in Fig. 2), the waveguide section **2** being also machined so as to project into the waveguide section **1** to press the frame member **4** against the seat **11** the said members being retained in assembled relation as by silver soldering. As thusly assembled, the waveguide sections **1** and **2** form in effect a continuous guide without variation in cross-sectional area and the inclination of the window **3** serves to eliminate reflec-

tions inasmuch as any reflections set up by the upper portion of the frame member **4** are automatically cancelled by those set up by the lower portion of this frame member since such reflections are out of phase. Since the window **9** is round, when this window is positioned within the guide it substantially provides a maximum transmittal area in the middle of the guide where the E waves are strongest as shown in Fig. 1A and the window becomes narrower gradually toward the sides of the guide where the E waves are less intense so that this novel window is highly efficient in the transmission of energy at the dominant mode of the guide. Since the window is inclined, there is no great tendency for the guide to break down adjacent the window such as is often the case in transverse guides shown, for example, in Fig. 4 where the juncture of the window and the air space in the guide tends to break down due to the relatively short path provided for the E vectors. In the guide of this invention, owing to the inclination of the window, any breakdown must take place through the dielectric disc **9** as shown in Fig. 3 and this is extremely difficult or impossible. Also, owing to the fact that the folds **6** and **7** of the hollow flange member **5** are rounded there is no tendency for breakdown to occur between these flanges and the upper and lower walls of the guide, which tendency would exist where a simple straight flange is used. Furthermore, the folds **10** and **6** give the hollow flange member **5** great flexibility allowing for relative thermal expansion and contraction of the window **9** with respect to the frame member **4**, thus insuring long life of the window regardless of the transmission of extremely heavy loads therethrough since heating up of the window does not tend to cause cracking at the joint between the window **9** and its frame member **4**.

Figs. 6 through 8 show a slightly modified arrangement wherein improved matching is obtained through use of metallic wedge elements or members **13** and **13'** attached to the upper and lower walls of the guide and positioned centrally therewithin, the said wave members having their wide ends just touching the flanges **6** and **7** at the upper and lower portions of the guide and then tapering to a fine edge away from the flange **5**, thus aiding in eliminating any possible reflection due to the presence of the frame member in that region of the guide where the E vector is strong. Note in these figures that the flange **7** is cut off short so that the same is spaced somewhat from the remainder of the frame member **4** although this structure is optional.

In Figs. 9 and 10 the novel window **3'** is shown inclined simultaneously in both planes of the guide. Thus, while the window is inclined with respect to the upper and lower walls of the guide as previously described, it is also inclined with respect to the side walls of the guide, the frame member **4'** forming an angle $\theta$ with respect to the narrow wall of the guide as shown in Fig. 10, thereby still further eliminating any tendency toward reflections taking place in use.

In Figs. 11 and 12 the waveguide sections **1'** and **2'** are shown provided with opposed external flanges **14** and **15** between which frame member **16** of the window is confined. In these figures and in Fig. 13 the frame member is shown provided with an offset flange **17** to which the ceramic window **19** is secured as by a molymanganese seal. In use, yielding of the offset flange **17** provides necessary temperature compensation between window **19** and the frame member **16**. If desired, the flanges **14** and **15** can be made as separae parts and attached to the waveguide sections. In Fig. 13 guide members **1** and **2** are similar to that shown in Fig. 1 with the frame member **20** similar to frame member **16** gripped therebetween and sealed thereto as by silver soldering.

Fig. 14 shows a construction similar to that of Fig. 13 except the offset flange is provided with an extra fold **21** to allow for greater flexibility in permitting thermal expansion and contraction.



As thusly constructed, the novel window of this invention provides for efficient transfer of energy without breakdown, without reflections and without breakage of the seal inasmuch as thermal expansion and contraction of the window and its frame member is compensated for due to the novel construction of the frame member.

Since many changes could be made in the above construction of the novel window of this invention and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In combination, a rectangular waveguide, a radio frequency window comprising a rectangular metallic frame member extending transversely of said guide and inclined with respect to the longitudinal axis of said guide with its outer edge portions secured to the walls of the guide and sealed thereto in vacuum tight relation, said frame member having a circular opening therewithin extending across the major portion of said frame member and said waveguide with the center of said opening substantially coinciding with the longitudinal axis of said waveguide, said frame member having a flexible flange attached thereto and extending around the periphery of its opening, said flange having a portion curving away from the main body of the said frame member and a cylindrical portion to provide a flexible support, a window of low loss dielectric material within said frame member opening and having its periphery cemented in sealed relation to said flange cylindrical portion, the said flange providing a yieldable support for said window permitting relative thermal expansion and contraction of the window with respect to its supporting frame member, said window and frame member forming an airtight seal within said guide enabling a vacuum to be maintained on one side of said window and frame member while atmospheric pressure may exist on the other side thereof, said window permitting the transmission of relatively large power of broad frequency band without electrical breakdown.

2. In a rectangular waveguide, a radio frequency window comprising a metallic frame member extending transversely of said waveguide and inclined with respect to the longitudinal axis of said guide, said frame member having its outer edges secured to the walls of said waveguide in vacuum tight sealing relation, said frame member being provided with a circular opening therewithin extending across the major portion of said waveguide with the center of said opening substantially coinciding with the longitudinal axis of said waveguide, said frame member having a yieldable curved flange extending in the form of a circle around the periphery of its opening, the circular inner portion of said flange being cylindrical and extending transversely of said frame member, a window of low loss dielectric material within said frame member opening and having its periphery cemented to the cylindrical transversely extending portion of said yieldable flange in vacuum tight sealing relation, the curved portion of said flange providing a yieldable support for said window permitting relative thermal expansion and contraction of the window with respect to its supporting frame member, said window and frame member forming an airtight seal within the guide and providing for low loss transmission of electromagnetic energy of wide frequency band.

3. In a rectangular waveguide as recited in claim 2 wherein said frame member yieldable curved flange is folded upon itself and has rounded folds at both sides of its transverse portion extending completely around the periphery of said window thereby preventing electrical breakdown between the flange and the walls of the guide in use in addition to permitting relative thermal expansion and contraction of said window and its frame member.

4. In combination, a rectangular hollow pipe waveguide comprising two separable metallic sections having sloping mating surfaces, a metallic frame member having a substantially flat main portion with its peripheral edge portion confined between said mating surfaces in sealed relation thereto and being inclined to the longitudinal axis of said waveguide, said frame member having a central circular aperture surrounded with a flexible peripheral flange that is yieldable with respect to the main body of said frame member, said flange comprising a transverse cylindrical portion connected to the main portion of said frame member by at least one annularly extending rounded portion, a dielectric circular window within said aperture having its periphery cemented to said flange, said rounded portion yielding in use to permit relative thermal expansion and contraction of said window with respect to its frame member support and at the same time due to its rounded nature preventing electrical breakdown between said flange and the inner wall of said guide.

5. A vacuum seal window for rectangular waveguides comprising a metallic rectangular frame member fitting within the guide and extending an acute angle with respect to the upper and lower walls of the guide and having its peripheral portion secured to and sealed with respect to the walls of the guide, said frame member having a central circular aperture surrounded by a flange, said flange having a transverse cylindrical inner wall connected to the main portion of said frame member by a multi-folded connecting portion of said frame member, a ceramic circular window fitting within said aperture with its peripheral edge fixedly cemented to the transverse cylindrical portion of said flange, the multi-folded portion of said frame member serving by yielding to permit relative thermal expansion and contraction of said ceramic



and frame member while maintaining a vacuum-tight seal between the window and frame member, and metallic conducting wedge members narrower than the guide extending longitudinally therewithin with their thick edges adjacent the upper and lower folds of said folded connecting portion and lying in the acute angles extending between said vacuum sealed window and the upper and lower walls of said guide.

6. In combination a rectangular hollow metallic waveguide comprising a pair of separable sections, each section having complementary ends inclined both with respect to the wide and narrow walls of the guide and a window comprising a metallic frame member fitted between said complementary ends of said guide sections and having a circular low loss dielectric window therewithin, the joints between said frame member and said guide walls and between said frame member and said window being airtight to provide a vacuum seal, the frame member having an offset folded flange portion surrounding said window and forming a yieldable support for the latter.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,628,438 | Simons | May 10, 1927 |
| 2,085,277 | Smith | June 29, 1937 |
| 2,444,303 | McCarthy | June 29, 1948 |
| 2,454,741 | McCarthy | Nov. 23, 1948 |
| 2,478,245 | Cork | Aug. 9, 1949 |
| 2,555,349 | Litton | June 5, 1951 |
| 2,584,653 | Alpert | Feb. 5, 1952 |
| 2,637,776 | Edson | May 5, 1953 |
| 2,706,275 | Clark | Apr. 12, 1955 |
| 2,734,174 | Heins | Feb. 7, 1956 |
| 2,744,592 | Remond | May 8, 1956 |