Sept. 9, 1947. D. G. CLIFFORD 2,427,089

SWITCH

Filed Oct. 28, 1942

Fig. 1.

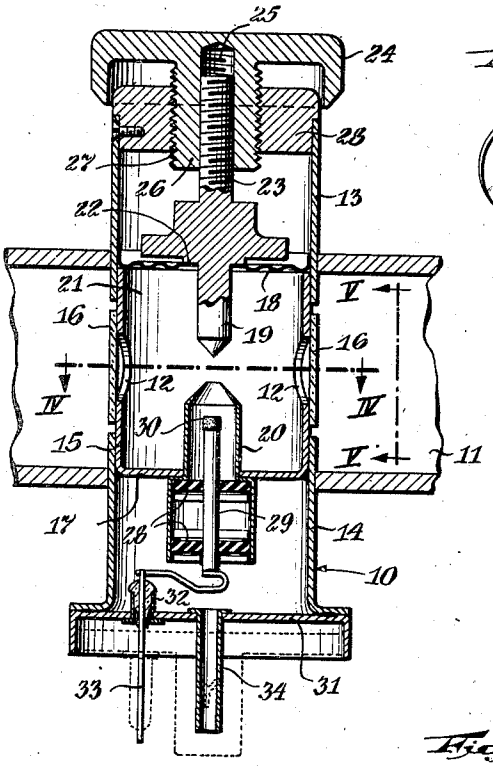


Fig. 3.



Fig. 2.

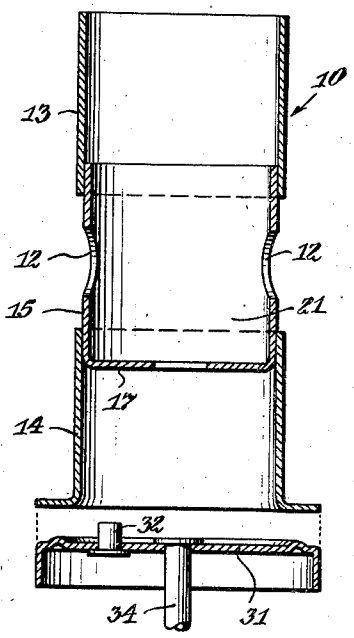


Fig. 4.

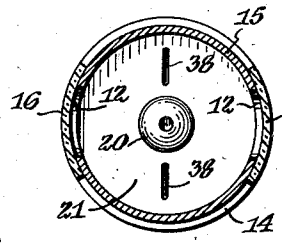


Fig. 5.

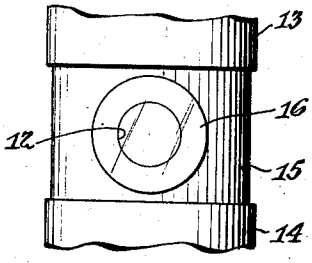


Fig. 6.

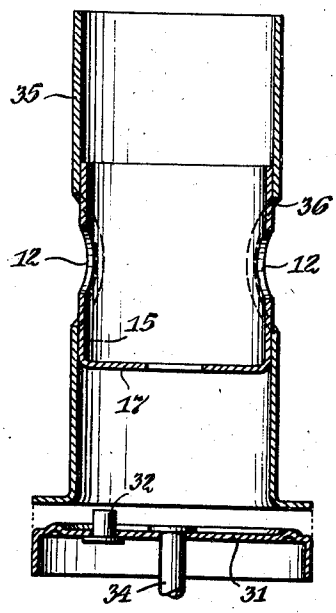
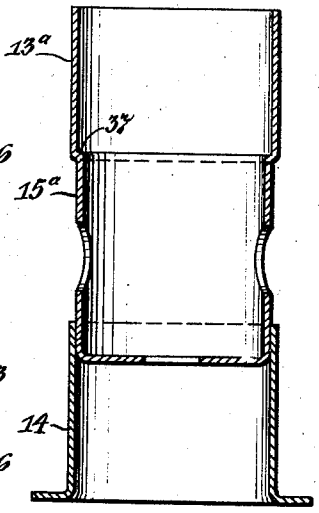


Fig. 7.



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SWITCH

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Application October 28, 1942, Serial No. 463,663

6 Claims. (Cl. 178—44)

1

This invention relates generally to switches, and more particularly to automatic resonant cavity switches of the type generally referred to in the trade as TR Boxes.

Devices of the general character above specified are used in connection with wave guides in a system which includes a source of ultra high frequency or micro-wave generation for promulgation of the wave energy into space where it is reflected from an object, such as an airplane, and returns to the wave guide and to a receiver connected therewith. The function of the TR Box is to protect the receiver from the high power of the transmitted signal but to provide for passage of the returning weak signal to the receiver. The general construction of TR Boxes includes an evacuated resonant chamber having windows looking in opposite directions into the wave guide axially thereof. Inclusion of such windows and in a manner to permanently maintain the vacuum within the chamber, has presented a problem not heretofore satisfactorily solved either from an economical manufacturing standpoint or from an efficiency standpoint.

The present invention accordingly has for its general object the provision of a TR Box overcoming the manufacturing and efficiency difficulties heretofore encountered.

More specifically, an object of the invention is to provide a switch as characterized having improved window construction.

Closely related to the preceding object is the desideratum that window construction be provided which is practical for mass production of the switches.

Another object of the invention is to provide a switch construction including windows and which will assure maintenance of desired evacuation of the resonant chamber.

A further object of the invention is to provide a construction made from a minimum number of parts and to maintain accuracy of dimensions of the asembly thereof.

Yet another object of the invention is to provide delicate but sturdy tuning mechanism in a switch of the character indicated.

Still further objects of the invention will appear as the description progresses, both by direct mention thereof and by implication from the context.

Referring to the accompanying drawing in which like numerals of reference indicate similar parts throughout the several views;

Figure 1 is a sectional view on a plane longitudinal of both the switch and the adjoining wave guide;

2

Figure 2 is a similar sectional view of the metallic shell portion of the switch partly assembled;

Figure 3 is a perspective view of the window closure alone;

Figure 4 is a cross-sectional view on line IV—IV of Fig. 1;

Figure 5 is an elevation from within the wave guide looking toward one of the windows, as on line V—V of Fig. 1; and

Figures 6 and 7 are sectional views similar to Fig. 2, showing modified constructions of shells.

In the specific embodiment of the invention illustrated in said drawing, the switch is illustrated as comprising in general a cylindrical shell 10 composed of several parts more fully described hereinafter, the axis of said shell being perpendicular to and intersecting the center-line or axis of a wave guide 11 of rectangular cross-section. Opposite end portions of the shell protrude at opposite sides of the wave guide and the diameter of the shell is such that it physically blocks the entire internal passage of the wave guide. The shell has two window openings therein situated at diametrically opposite parts thereof and shown circular with their centers coincident with the center-line of the wave guide. Energy in the wave guide at one side of the shell has to pass through said windows 12 to enter the part of the wave guide at the other side of said shell. For effective operation of the switch, the region within the shell for that part thereof passing through the wave guide, is evacuated and in some instances charged with a gas of appropriate character and amount. This necessitates that said region must be a closed chamber, and in the prior art, as well as in the present invention, the windows are sealed with a closure of suitable material, usually glass, which will be transparent to the wave energy desired to pass therethrough. The construction and sealing of these closures constitutes a feature of the present invention.

Returning now for a more detailed description of the shell and its associated parts, the construction shown in Figures 1 to 5 inclusive comprises cylindrical end portions 13, 14 which for convenience will be referred to as the upper and lower end sections respectively. Said sections are shown of equal diameters and axially aligned with the inner ends or ends directed toward each other within the wave guide but separated from each other a distance greater than the diameter of the windows and of the closures therefor. Spanning the distance between the inwardly

facing ends of the end sections is a cup-shaped cylindrical mid-section 15 the end margins of the cylindrical wall of which are within and juxtaposed to the end margins of the said end sections. A vacuum-tight seal is made between these lapping margins, by welding, soldering, brazing or otherwise. Said cup-like mid-section is preferably made of iron for purposes of obtaining a secure seal with the glass closures for the windows as hereafter mentioned. Said windows 12 are cut through the cylindrical wall of the mid-section diametrically opposite each other and on a common axis. Said axis is represented by section line IV—IV and when the shell is assembled in the wave guide said axis is made coincident with the center line of the wave guide.

Said windows 12 are covered with closures 16, 16, one for each, it being particularly noted that the application of said closures is from the outside of the assembled shell so that placing the closures may be delayed to be one of the final assembly operations. The said closures are preferably formed from plain discs of glass or other material transparent to the wave energy to be passed therethrough in use, and are of greater diameter than the windows so as to marginally overlap on the metal of the shell mid-section around said windows. Application of appropriate heat, by a flame or otherwise, permits said glass discs to be bent to assume the same curvature as said mid-section of the shell and to engage the said metal around the entire peripheral margins of the closures at the margin of metal around the windows. Further appropriate application of heat to the closure will fuse the material thereof into sealing engagement with the metal. A preferred metal for mid-section 15 is cold rolled steel, soft iron or other metal preferably copper plated, and the glass is preferably Corning #1991, which is a high expansion, low density, lead glass. The glass forming the closure is of uniform thickness throughout the part seen through the opening of the window, the sealing covers a material area of metal thereby assuring secure and intimate attachment to the metal, and the sealing operation being readily effected from the exterior of the shell may be delayed as a final step before exhausting.

Said mid-section of the shell preferably comprises the resonant chamber, and its length is therefore critical, as mathematically length of a resonant chamber enters into the formula for resonant modes. Said mid-section is formed with an integral and fixed bottom wall 17 and with a metallic and flexible top wall 18. Said top wall is shown as a corrugated diaphragm having a peripheral flange sealed to the shell so as to position the said top wall directly at the otherwise open end of the cup-like intermediate section. Both the top and bottom walls are provided with central openings through which protrude electrodes 19, 20 respectively, said electrodes being sealed to their respective walls so as to maintain the sealed condition of the chamber 21 formed by said section and its end walls. Said electrodes are directed toward each other on the axis of the shell with the ends of the electrodes in proximity to and on opposite sides of the afore-mentioned axis of the windows and center line of the wave guide represented by line IV—IV.

The upper electrode 19 is shown as of solid construction suitably flanged, as at 22 above the flexible end wall 18 for sealing purposes with respect thereto, and provided with an upwardly extending threaded stem 23 for holding and

adjusting the said electrode. A thumb-nut or adjusting knob 24 is provided with internal threads 25 to engage the threaded stem, said nut or knob also providing a coaxial hub 26 with external threads 27 thereon screwing through a fixed cap 28 carried at the end of the shell. Threads 25 and 27 may both be in a common direction, for instance, right hand threads, but of different pitch or otherwise constructed to afford a differential in operation and obtain a fine adjustment of longitudinal movement of the stem and electrode with a considerable rotation of the nut or knob 24.

Lower electrode 20 is shown as a hollow cylinder with an open frusto-conical end and mounted within this cylinder between suitable ceramic or other insulative support 28 is a keep-alive electrode 29. The forward end of this keep-alive electrode is emissive, either inherently so by being tipped at 30 with radium or the like, or effectually emissive through a potential difference between said keep-alive electrode and the surrounding cylindrical electrode, in which event the keep-alive electrode is composed of or tipped with emissive material of usual or desired composition for emissive electrodes.

The bottom end of lower end-section 14 of the shell is flanged outward and projection welded to an end wall 31. An eyelet 32 is sealed to and through this end wall for a lead 33 to the keep-alive electrode, said eyelet and lead being glass-beaded for sealing purposes. A tubulation 34 also is sealed through the end wall and constitutes the means for evacuation and for gas-charging if desired. Slits 38 or other openings may be provided in the bottom wall of the cup 15 for evacuation purposes. It will be understood that the interior of the shell from the said end wall 31 to the flexible diaphragm 18 is the region affected by evacuation and recharging but that the interior of the cup-like mid-section 15, namely, chamber 21, is the resonant chamber for the device.

While the foregoing description has specifically referred to the shell as comprised of various parts, it is to be understood that many changes in construction and in steps of manufacture may be substituted within the present inventive concept. For instance, in Figure 6, the shell shown is composed of a full-length cylinder 35 and is provided in place of the end sections 13, 14 of the construction above described. This full-length cylinder has diametrically opposed holes 36 therein approximately midway of its length, said holes being larger than the window closure. Within the one-piece outer section represented by said cylinder 35, is situated the copper-plated iron cup-like mid-section 15 as in the previously described construction. It will be understood that in use the shell of Figure 6 is substituted for shell 10 of the preceding figures and used with the electrodes, end walls and adjusting means shown therein.

In making the assembly of Figure 6, the windows 12 of the mid-section 15 are centered with respect to the larger holes 36 of the shell. The closures 16 will be softened, curved to fit and applied to the surface of the mid-section overlapping the windows as before, but in this instance will be within the holes 36 of the shell.

In the modified construction of Figure 7, upper end section 13*a* is shown integral with mid-section 15*a*, the lower end section 14 remaining as described in connection with Figure 1. Combined sections 13*a*—15*a* may be provided with a

shoulder 37 corresponding in position and effect to the upper end of the mid-section, and may thus be utilized to maintain the critical length of the resonant chamber when assembling the flexible diaphragm wall therewith.

It is to be understood that other modifications and changes may be made which do not require specific showing herein as they come within the inventive concept fully described above and explicitly set forth in the following claims.

I claim:

1. A switch comprising a cylindrical shell having a mid-section and another section of greater diameter overlapping the mid-section, said mid-section comprising a resonant chamber, an end wall for the overlapping section, an opposite end wall at the end of the mid-section, electrodes in the mid-section, said mid-section having windows at opposite sides thereof on an axis passing between the said electrodes, and closures for said windows.

2. A switch comprising a cylindrical shell having a mid-section and another section of greater diameter overlapping the mid-section, said mid-section comprising a resonant chamber, an end wall for the overlapping section, a flexible diaphragm constituting an opposite end wall at the end of the mid-section, electrodes in the mid-section of which one electrode is carried by said flexible diaphragm, said mid-section having windows at opposite sides thereof on an axis passing between the said electrodes, and closures for said windows.

3. A switch comprising a resonator having a cylindrical shell, opposed electrodes in said shell coaxial therewith, said electrodes being longitudinally separated one from the other providing a gap therebetween, said shell having windows in opposite sides thereof centered on a diameter of the shell transverse to said electrodes and opposite said gap, said windows being adapted one to admit wave energy into said resonator and the second to pass wave energy to the exterior of the resonator, said electrodes constructed and arranged for disrupting resonance in said resonator of high power wave energy and preventing outward propagation through the second window of high power wave energy.

4. A switch comprising a resonator having a cylindrical shell, opposed electrodes in said shell coaxial therewith, said electrodes being longitudinally separated one from the other providing a gap therebetween, one said electrode being hollow, a keep-alive electrode within the hollow electrode, said shell having windows in opposite sides thereof centered on a diameter of the shell

transverse to said electrodes and opposite said gap, said windows being adapted one to admit wave energy into said resonator and the second to pass wave energy to the exterior of the resonator, said electrodes constructed and arranged for disrupting resonance in said resonator of high power wave energy and preventing outward propagation through the second window of high power wave energy.

5. In combination, a hollow wave guide having an internal passage, a discontinuity in said passage transversely of and completely blocking the same, said discontinuity comprising a resonator having its length in direction of and substantially equal to cross sectional height of the wave guide, said resonator having windows looking into said wave guide in opposite directions from the resonator, and a window-closure for each window permeable to electromagnetic wave propagation in the wave guide from one side of the discontinuity to the other.

6. In combination, a hollow wave guide having an internal passage, a discontinuity in said passage transversely of and completely blocking the same, said discontinuity comprising a resonator having its length in direction of and substantially equal to cross sectional height of the wave guide, said resonator having windows looking from said resonator in opposite directions into said wave guide at the part thereof central with respect to the wave guide and of less area than the cross sectional area of the wave guide at the discontinuity, and a window closure for each said window permeable to electromagnetic wave propagation in the wave guide through said closure from one side of the discontinuity to the other.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,093,567	McCullough	Sept. 21, 1937
2,218,331	Etzrodt	Oct. 15, 1940
2,298,335	Atlee	Oct. 13, 1942
2,148,488	McEuen	Feb. 28, 1939
2,407,690	Southworth	Sept. 17, 1946
2,407,069	Fiske	Sept. 3, 1946
2,200,023	Dallenbach	May 7, 1940
2,197,122	Bowen	Apr. 16, 1940

FOREIGN PATENTS

Number	Country	Date
484,144	Great Britain	Nov. 29, 1937