

April 12, 1955

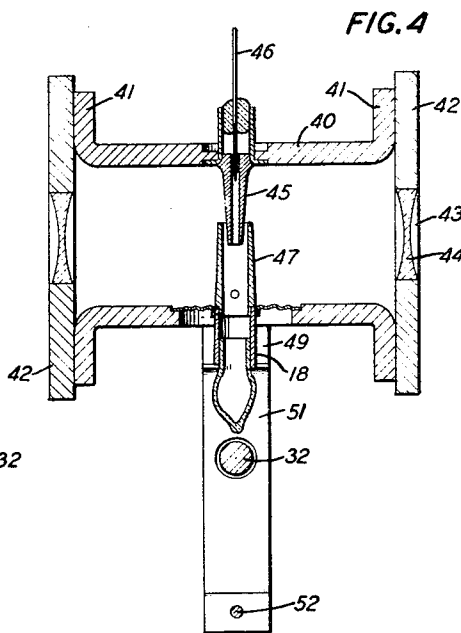
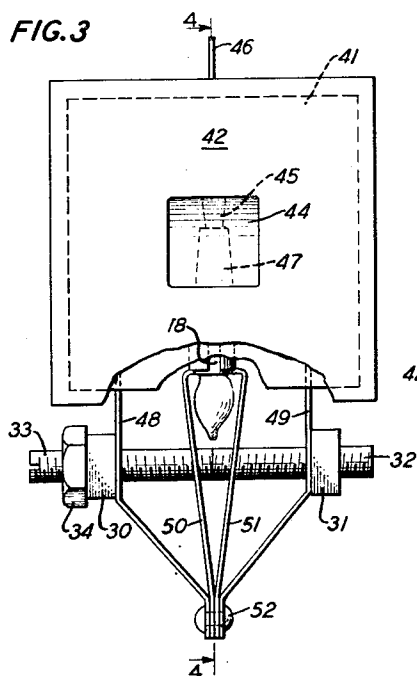
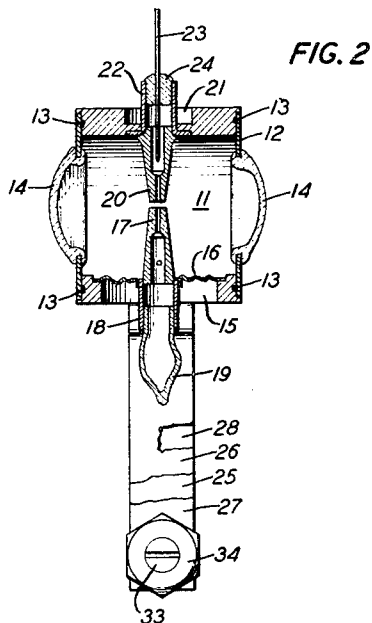
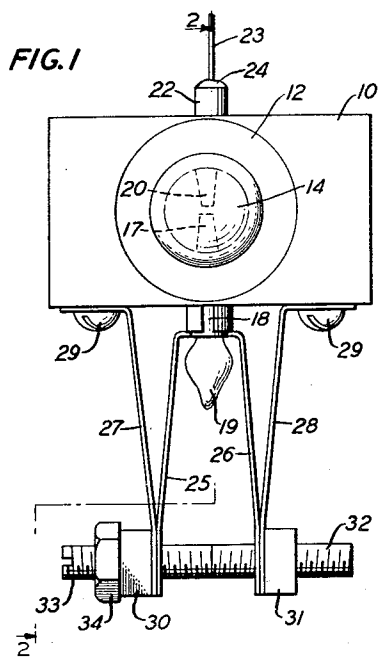
A. E. ANDERSON

2,706,263

GAS DISCHARGE TRANSMIT-RECEIVE SWITCH

Filed Oct. 23, 1946

2 Sheets-Sheet 1



INVENTOR
A.E. ANDERSON
BY
Franklin Mohr
ATTORNEY

April 12, 1955

A. E. ANDERSON

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FIG. 5

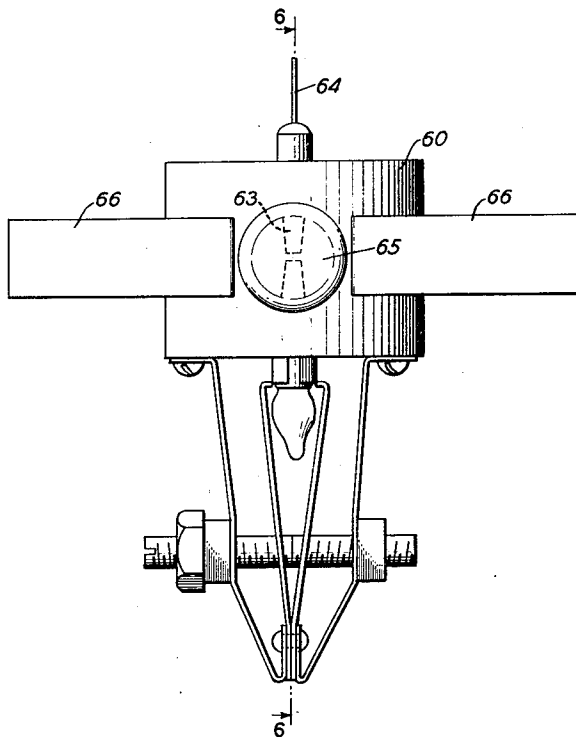
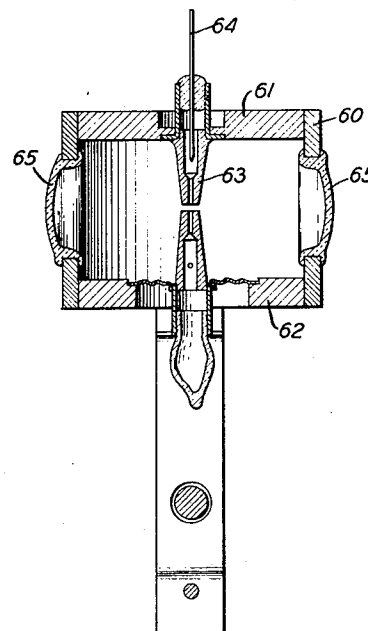


FIG. 6



INVENTOR
A. E. ANDERSON
BY
Franklin Mohr
ATTORNEY

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GAS DISCHARGE TRANSMIT-RECEIVE SWITCH

Alva Eugene Anderson, Chatham, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

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4 Claims. (Cl. 313—148)

This invention relates to electromagnetic resonators for microwaves and more particularly to resonators adapted for use as gas discharge or ionic switches, still more particularly as transmit-receive switches in duplex transmission systems.

The invention resides in a cavity resonator, the entire interior of which is comprised in a gas-tight envelope, and which may contain a filling of ionizable gas.

A feature of the invention is a coupling device for leading microwaves into and out of a cavity resonator, the coupling comprising a cavity wall having an aperture therein and a gas-tight closure mounted in said aperture and sealing the same, the closure being composed of a material transparent to electromagnetic waves of the operating frequency of the cavity resonator. In a preferred embodiment of the invention a glass closure is employed in the aperture.

Another feature of the invention is a pair of discharge electrodes mounted inside the resonator on opposite portions of the wall thereof, one of the electrodes being movably mounted as upon a flexible diaphragm forming a portion of the wall of the resonator.

A further feature of the invention is a telescoping arrangement for the electrodes whereby one of the electrodes is hollow and open at one end to receive therein a variable portion of the opposing electrode, for the purpose of increasing the tuning range of the resonator. By virtue of this feature the separation of the nearest contiguous portions of the respective electrodes remains approximately constant over a considerable tuning range. This tends to keep the voltage breakdown conditions independent of the operating frequency, which makes for better and more consistent operation particularly when the device is used as a gas discharge switch.

A still further feature of the invention is a toggle device mounted between the flexible diaphragm and the outer surface of the main body of the resonator for adjusting the separation of the electrodes by flexure of the diaphragm.

A number of illustrative embodiments of the invention are particularly described herein while the scope of the invention is defined in the appended claims.

In the accompanying drawings, Fig. 1 is an elevational view of one embodiment of the invention;

Fig. 2 is a sectional view of the same embodiment shown in Fig. 1;

Fig. 3 is an elevational view, partly broken away, showing a second embodiment of the invention;

Fig. 4 is a sectional view of the same embodiment shown in Fig. 3;

Fig. 5 is an elevational view of a further embodiment of the invention; and

Fig. 6 is a sectional view of the same embodiment shown in Fig. 5.

Referring to Figs. 1 and 2, there is shown therein a block 10 of copper or other material suitable for a cavity resonator. The block 10 has a hollowed out portion 11, preferably cylindrical, produced in any suitable manner, as for example by boring. The portion 11 preferably extends entirely through the block 10. At each end of the opening 11 there may be provided an annular member 12 attached to the block 10 in any suitable manner, as for example by means of a ring 13 of solder embedded in a groove in the block 10. The member 12 serves to reduce the size of the exterior opening to any desired degree and forms a suitable frame in which is mounted a window or crystal 14, the latter being of a material trans-

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parent to electromagnetic waves of the operating frequency of the cavity resonator. The member 14 may be of glass and it may be curved to increase its strength, with a convex surface directed outward.

Extending generally in a direction perpendicular to the axis of the opening 11 there is preferably provided an opening 15 leading into the opening 11. The opening 15 has mounted around its edge a flexible diaphragm 16 to which is attached a hollow electrode 17 extending inwardly into the opening 11 and a tubular member 18 extending outwardly through the opening 15. A glass tubulation 19 is preferably attached to the member 18 and sealed to the interior thereof for use in evacuating the interior of the cavity resonator.

Opposite the electrode 17 is mounted a second electrode 20 which is preferably hollow and may be suitably mounted as in an opening 21 in the wall of the resonator. A tubular member 22 with a flaring end extending into the opening 11 may be brazed in place or otherwise suitably attached to the electrode 20 and the block 10. A keep-alive electrode comprising a rod or wire 23 may be mounted inside the element 22 so as to extend into the hollow portion of the electrode 20. The rod 23 may be held in place and the closure of the opening 11 completed by means of a seal 24 which may be of glass or other suitable insulating material. The electrodes 17 and 20 are each perforated in such manner as to provide access to all interior portions of the assembly during exhaustion through the tubulation 19 and to decrease the inherent capacitance between the electrodes, as much as may be desired. The perforation of the electrode 20 also insures that the keep-alive electrode 23 will be immersed in the same atmosphere which pervades the opening 11.

Mounted between the member 18 and the outer surface of the block 10 is a toggle arrangement comprising members 25 and 26 attached as by soldering or brazing to the element 18 and members 27 and 28 attached as by means of screws 29 to the block 10. The elements 25 and 27 are joined to a nut 30 and the elements 26 and 28 to another similar nut 31, oppositely threaded with respect to the nut 30. A bolt 32, the ends of which are likewise oppositely threaded engages the nuts 30 and 31. A screw-driver slot 33 may be provided in one end of the bolt 32 and a lock nut 34 may be threaded upon one end of the bolt 32.

In the assembling of the device of Figs. 1 and 2, it may be convenient to first mount the electrode 20 and the tube 22 in the opening 21 and secure them in place. The lead-in rod 23 may then be inserted into the hollow portion of the electrode 20 and the glass seal 24 may be inserted to hold the member 23 in place and to complete the closure of the opening 21. The electrode 17, the diaphragm 16, and the element 18 may next be united into a unit and the tubulation 19 with both ends open may be suitably attached to the inside of the element 18. The sub-assembly thus formed may then be mounted in place as by brazing the outer edge of the diaphragm 16 to the block 10 around the periphery of the opening 15. The annular members 12 may then be soldered in place and the closures 14 applied.

The toggle arrangement may be attached to the element 18 either before or after assembly of the diaphragm unit. After assembly the members 27 and 28 of the toggle arrangement may be attached to the block 10 by inserting the screws 29. The interior of the cavity resonator then may be evacuated in known manner through the tubulation 19 and a filling of ionizable gas, if desired, may be inserted, after which the tubulation may be sealed off in known manner.

In the operation of the device of Figs. 1 and 2 as an ionic switch, a filling of ionizable gas is required in the opening 11. The cavity resonator may be tuned by turning the bolt 32, thus varying the spacing between the electrodes 17 and 20 by means of the toggle arrangement which moves the electrode 17 through the intermediary of the diaphragm 16. The windows 14 may be used as input and output openings, respectively, for leading electromagnetic waves into and out of the cavity resonator, in well known manner, and the flat sides of the block 10 may be employed as coupling flanges in attaching the

resonator to a wave guide structure. When an electromagnetic wave of predetermined high intensity and of the predetermined operating frequency enters the cavity resonator, the electric field between the electrodes 17 and 20 becomes sufficiently intense to cause a discharge between these electrodes thereby effectively short-circuiting the cavity resonator and detuning the same so that an intense electromagnetic wave entering one of the windows 14 will not be appreciably transmitted through the other window. Electromagnetic waves of less than the critical intensity and of the predetermined operating frequency are transmitted through the device and do not cause a discharge between the electrodes 17 and 20. The keep-alive electrode 23 is employed in known manner to set up a small steady electric field between the element 23 and the interior of the electrode 20, thereby insuring the presence of a sufficient supply of ions at all times. This enables the main discharge to build up very rapidly, using the initial supply of ions to accelerate further ionization and a breakdown in the space between the electrodes 17 and 20.

Referring now to Figs. 3 and 4, there is shown a modified embodiment of the invention in which instead of a block 10 there is provided as the main portion of the wall of the cavity resonator a hollow tube of rectangular cross-section 40 the ends of which may be flared to form flanges 41. End plates 42 are attached to the flanges 41 to complete the main closure of the cavity resonator. Each plate 42 may be provided with an aperture 43 in which is mounted a closure 44 which may be of glass. The closure 44 may have concave sides as shown in Fig. 4 and may be contained entirely within the aperture 43 as contrasted with the closure 14 of Fig. 2 which is convex, extends outside the aperture and is fastened to both sides of the annular member 12. A fixed electrode 45 and a keep-alive electrode 46 may be provided similarly as in the embodiment of Figs. 1 and 2. In Fig. 4, however, the movable electrode 47 preferably has a large enough opening at the inner end to provide room for a telescoping of the electrodes 45 and 47 to increase the range of variable capacitance between these electrodes, thereby increasing the tuning range available. Fig. 3 shows an alternative form of toggle arrangement for adjusting the position of the electrode 47. Members 48 and 49 of the toggle arrangement are mounted on the member 40 and are attached respectively to the nuts 30 and 31. Elements 50 and 51 are attached to the member 18 and have clearance holes for the passage of the bolt 32 therethrough. The elements 48, 49, 50 and 51 are all joined together by a bolt or rivet 52. Similarly as in the arrangement of Figs. 1 and 2, adjustment of the bolt 32 produces a motion which is transmitted to the element 18 and the electrode 47 to vary the amount of overlapping of the electrodes 45 and 47. Clearance is preferably maintained between the electrodes 45 and 47 throughout the extent of the relative motion of these electrodes. The end plates 42 may be used as coupling flanges in attaching the resonator to a wave guide structure.

Referring finally to Figs. 5 and 6, there is shown therein another alternative form of the invention. A hollow cylindrical member 60 has end plates 61 and 62, the former having mounted thereon a fixed hollow electrode 63 and a keep-alive electrode 64. The end plate 62 has mounted thereon a movable electrode, a flexible diaphragm, and exhaust tubulation, similar to what is shown in Figs. 2 and 4. Opposite side walls of the cylinder 60 contain circular apertures sealed by glass members 65. A toggle arrangement similar to that shown in Fig. 3 is provided but due to the alteration of the leverages involved there will result a finer adjustment of the electrode spacing than can be expected with the arrangement of Fig. 3.

Mounting flanges or lugs 66 may be provided and suitably attached to the cylindrical element 60 in the arrangement of Figs. 5 and 6. These lugs may be used in coupling the cavity resonator to a wave guide by virtue of the coupling through the element 65.

As is well known in the art of cavity resonators, the inner surfaces of the cavity should be composed of highly conductive material, which may either be part of a solid block as of metal of high conductivity or may comprise a plating or coating of highly conductive material upon any suitable supporting structure.

The device of the invention may be used in many organizations. With a filling of ionizable gas the device may be used as an ionic switch as for example, a transmit-receive switch in a duplex transmission system. Either evacuated or gas-filled the device may be used as a cavity resonator of either fixed or adjustable tuning and is adapted when tunable to operate over a relatively broad band of operating frequencies.

What is claimed is:

1. A cavity resonator comprising a block of conductive material having a cylindrical opening extending therethrough, said block having an additional opening through a side wall into said cylindrical opening, a pair of gas-tight closures mounted one over each end of said cylindrical opening and sealing the ends of said opening, a flexible conductive closure mounted over the said second-mentioned opening and sealing the same, a pair of electrodes mounted within said cylindrical opening, one of said electrodes being fixed to the inner wall of the cylindrical opening, the other of said electrodes being attached to the inside of said flexible conductive closure, and a toggle mechanism mounted between said flexible conductive closure and the external surface of said block.

2. A cavity resonator comprising a conductive block having a cylindrical opening therethrough, a pair of annular conductive members mounted one at each end of said cylindrical opening, a pair of glass closure members cooperating with said annular members thereby sealing the ends of said cylindrical opening, said block having an additional opening into a side wall of said cylindrical opening, a flexible conductive diaphragm attached to the edge of said second-mentioned opening, a hollow electrode attached to said flexible conductive closure, means sealing said second-mentioned opening, said means including a glass seal, said movable electrode being mounted inside said cylindrical opening, a fixed hollow electrode mounted inside said cylindrical opening and opposite side movable electrode, a keep-alive electrode mounted within the hollow portion of said fixed electrode, a glass seal for leading in said keep-alive electrode, and a toggle mechanism mounted between the exterior portion of said block and said flexible conductive closure.

3. A tuning device comprising a pair of truncated conical opposing members one of which is hollow, said members being mounted in axial alignment, and means for telescoping the said opposing members, the hollow portion of the hollow conical member receiving the other conical member.

4. A cavity resonator comprising a block of conductive material having a cylindrical opening extending therethrough, said block having an additional opening through a side wall into said cylindrical opening, a pair of gas-tight closures mounted one over each end of said cylindrical opening and sealing the ends of said opening, a flexible conductive closure mounted over the said second-mentioned opening and sealing the same, a pair of electrodes mounted within said cylindrical opening, one of said electrodes being fixed to the inner wall of the cylindrical opening, the other of said electrodes being attached to the inside of said flexible conductive closure, and means mounted between said flexible conductive closure and the external surface of said block for varying the position of the electrode which is attached to the inside of said flexible conductive closure.

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