July 16, 1957 M. A. BIONDI 2,799,804

RADAR TRANSMIT RECEIVE SWITCH

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Fig. 1.

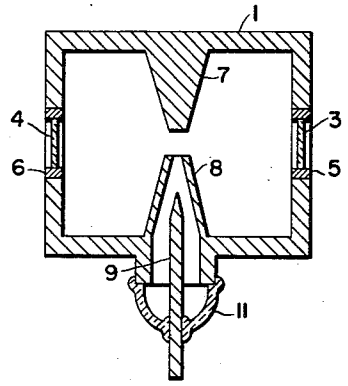
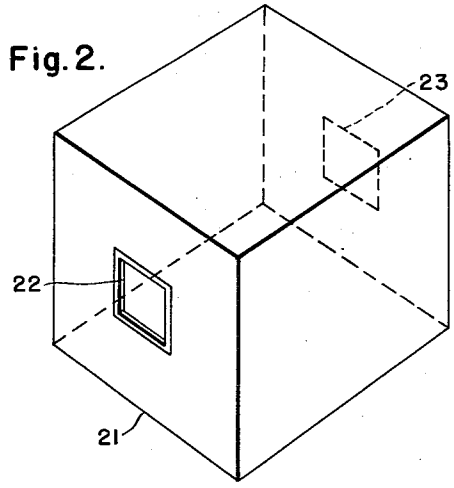


Fig. 2.



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RADAR TRANSMIT RECEIVE SWITCH

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My invention relates to gas-filled electrical discharge devices and in particular comprises a novel gas-filled transmit-receive switch, hereafter referred to as a "T–R switch," used for automatically connecting components, such as a radar receiver, into and out of certain high frequency electric circuits.

T–R switches have been widely used in radar circuits to permit a sensitive receiver of ultra short-wave signals to remain operatively connected to the antenna of a radar set to respond to incoming signals of low power except when the transmitter connected to the same antenna is supplying a pulse of enormously greater power. At the instant such a pulse appears at the point where the receiver is connected to the antenna, the T–R switch functions to short-circuit the receiver, by passing the pulse to the antenna and saving the receiver from the ruinous influx of energy which it would otherwise suffer.

To effect the above purpose, the T–R switch must change with great rapidity from a nearly non-conductive to a sufficiently conductive state when the pulse wavefront appears, and must change back again to the non-conductive condition with great rapidity when the pulse has passed.

One widely used form of T–R switch comprises a chamber containing a substantial quantity of a gas surrounding a pair of electrodes which are respectively connected across the channel leading electric pulses to the receiver inside a chamber which forms a cavity resonator. An ancillary chamber contains an auxiliary "keep-alive" electrode which maintains an electric discharge of low current density serving to supply a certain degree of ionization in low concentration to the gaseous atmosphere between the main electrodes. The U. S. Patent 2,525,468 to Daniel Alpert describes and claims such a T–R switch.

To effectively perform the above-described functions, it is necessary that the gas between the electrodes shall rapidly increase in ionization under a relatively moderate voltage-rise between the main electrodes, i. e. it should have a comparatively low break-down voltage; and it should deionize rapidly when the voltage is removed.

One object of my invention is accordingly to provide a novel T–R switch which shall have a low "recovery" (i. e. deionization) time.

Another object is to provide a novel T–R switch having a relatively moderate ignition (i. e. breakdown) voltage.

Still another object is to provide a gaseous atmosphere for electrical discharge devices which shall ionize and deionize with great rapidity.

Still another object is to provide a novel atmosphere for electrical discharge paths.

Other objects will become apparent upon reading the following description taken in connection with the drawings, in which:

Figure 1 is an elevational view in section of a cylindrical form of T–R switch in accordance with my invention; and,

Fig. 2 is a perspective view of a rectangular form of T–R switch and may be utilized advantageously as a pre-T–R switch.

Referring in detail to Fig. 1, the latter shows a section, on a plane through its central axis, of a chamber **1** which may be of any suitable metal such as brass or copper having a pair of windows **3** and **4** of glass connected to the metal by suitable rings **5**, **6** which may consist of the iron, nickel, cobalt alloy described in Scott Patent 2,062,335. A projection **7** on the wall of chamber **1** coacts with another projection **8** on the opposite wall to form a discharge gap. The projection **8** is hollow and in its axis is positioned an electrode **9** insulated from the walls of container **1** by a glass sealing member **11**. In use, as an electrical gradient exists between electrode **9** and projection **8** when the chamber **1** resonates, an electrical discharge is maintained between the electrode **9** and projection **8** from which gaseous ions migrate into the gap between projections **7** and **8**.

The container **1** contains an atmosphere of helium gas admixed with iodine vapor; for example, I have found helium at a partial pressure of about 30 mm. of mercury admixed with iodine at a partial pressure of 1 mm. of mercury to be satisfactory for many purposes, both pressures being given for thirty-five degrees centigrade. Under this condition there will be thirty helium molecules present for each iodine molecule.

In use the T–R switch of Fig. 1 is inserted in a wave guide so that the electric waves flow into it through one of the glass windows **3**, **4** and out through the other. When the electromagnetic field is of the low intensity characteristic of received signals coming from the antenna, the chamber **1** merely acts as a resonator, permitting the waves to flow through it to the receiver proper. When, on the other hand, the local transmitter sends out a pulse, the electric field in the chamber **1** rises to such an intensity as to produce a breakdown in the gas between projections **7** and **8** which short-circuits the wave guide and prevents transmittal of electric fields of harmful intensity through the outlet guide to the receiver.

Fig. 2 shows a rectangular type of T–R switch which has been found particularly useful as a pre-T–R switch, that is a resonant chamber inserted in the wave guide between the T–R switch and the antenna, and functioning as a T–R switch to short-circuit the line and reflect the greater part of the energy from a transmitter pulse before it reaches the T–R switch proper. If waves of intensity likely to be harmful to the receiver manage to pass the pre-T–R switch, the main T–R switch arcs over and reflects them as described in discussing Fig. 1.

Fig. 2 may comprise a simple box **21** of brass or copper having windows **22** and **23** in opposite sides made as described in connection with the windows of Fig. 1. In Fig. 2, there are no specific arc-over projections like projections **7**, **8** in Fig. 1, but, as the opposite edges of the window **22** or **23** have different electrical potential when the resonant chamber resonates, arc-over occurs between the opposite edges of window **22** or **23** when the electric field intensity of waves flowing in from wave guides covering these windows attains a dangerous intensity.

A filling of the same gaseous mixture described in connection with Fig. 1, and of the same pressure, is suitable for most purposes in using the T–R box of Fig. 2.

While I have described the gaseous filling of the T–R boxes in Figs. 1 and 2 as partial pressures of helium 30 mm. and iodine 1 mm. of mercury, hydrogen may be substituted for helium where rapid suppression of ionization in the gas is paramount even though attained at the expense of higher ignition voltage. Atmospheres in which either hydrogen or helium are present at partial pressures between 10 and 100 mm. of mercury with chlorine,

bromium, iodine, or sulphur hexafluoride (SF_6) present at partial pressures from 1 to 10 mm. of mercury are useful. The higher the pressure the shorter will be the recovery time, i. e., the peiod required to suppress ionization to a specified value, but the higher will be the ignition voltage required to cause breakdown across the electrodes of the switch. The gases listed for the lower pressure component in the mixture are electronegative gases.

I claim as my invention:

1. A T–R switch comprising an envelope having walls of conducting material forming a cavity resonator, a pair of opposed conductors forming a discharge gap between points of different electrical potential when said cavity resonator resonates, and a gaseous atmosphere consisting of helium admixed with iodine in said resonator.

2. A T–R switch comprising an envelope having walls of conducting material forming a cavity resonator, a pair of opposed conductors forming a discharge gap between points of different electrical potential when said cavity resonator resonates, and a gaseous atmosphere consisting of helium admixed with iodine in said resonator, the number of helium molecules being about thirty times the number of iodine molecules.

3. A T–R switch comprising an envelope having walls of conducting material forming a cavity resonator, a pair of opposed conductors forming a discharge gap between points of different electrical potential when said cavity resonator resonates, and a gaseous atmosphere consisting of helium admixed with iodine in said resonator, said atmosphere having a total pressure of about thirty mm. of mercury.

4. A T–R switch comprising an envelope having walls of conducting material forming a cavity resonator, a pair of opposed conductors forming a discharge gap between points of different electrical potential when said cavity resonator resonates, and a gaseous atmosphere consisting of helium admixed with iodine in said resonator, said atmosphere having a pressure of about thirty mm. of mercury and the number of helium molecules being about thirty times the number of iodine molecules.

5. An envelope of conducting material forming a cavity resonator, a gap within said resonator having its termini at points between which an electrical gradient exists when said cavity resonates, and an atmosphere within said envelope consisting of helium admixed with iodine.

6. An envelope of conducting material forming a cavity resonator, a gap within said resonator having its termini at points between which an electrical gradient exists when said cavity resonates, and an atmosphere within said envelope consisting of helium admixed with iodine, about thirty times as many helium molecules as iodine molecules being present.

7. An envelope of conducting material forming a cavity resonator, a gap within said resonator having its termini at points between which an electrical gradient exists when said cavity resonates, and an atmosphere within said envelope consisting of helium admixed with iodine, said atmosphere having a pressure of about thirty mm. of mercury.

8. An envelope of conducting material forming a cavity resonator, a gap within said resonator having its termini at points between which an electrical gradient exists when said cavity resonates, and an atmosphere within said envelope consisting of helium admixed with iodine, said atmosphere having a pressure of about thirty mm. of mercury and comprising about thirty times as many helium molecules as iodine molecules.

9. An electrical discharge envelope enclosing a pair of discharge electrodes and enclosing an atmosphere of helium admixed with iodine, there being about thirty helium molecules for each iodine molecule.

10. An electrical discharge envelope enclosing a pair of discharge electrodes and enclosing an atmosphere of helium admixed with about three percent by partial pressure of iodine, said atmosphere having a pressure of about thirty mm. of mercury, about thirty helium molecules being present for each iodine molecule.

11. A T–R switch comprising an envelope enclosing a pair of electrodes in an atmosphere consisting of gas at a partial pressure of 10 to 100 mm. of mercury drawn from the group which consists of helium and hydrogen and gas at a partial pressure of 1 to 10 mm. of mercury drawn from the group which consists of chlorine, bromine, iodine and sulphur hexafluoride.

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