Jan. 21, 1947. W. W. WATROUS, JR 2,414,622

SWITCH

Filed March 20, 1942

Fig. 1.

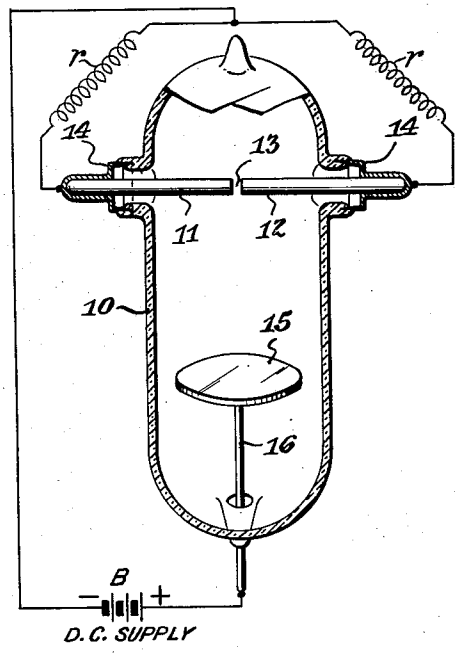


Fig. 2.

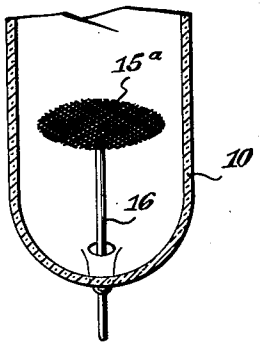
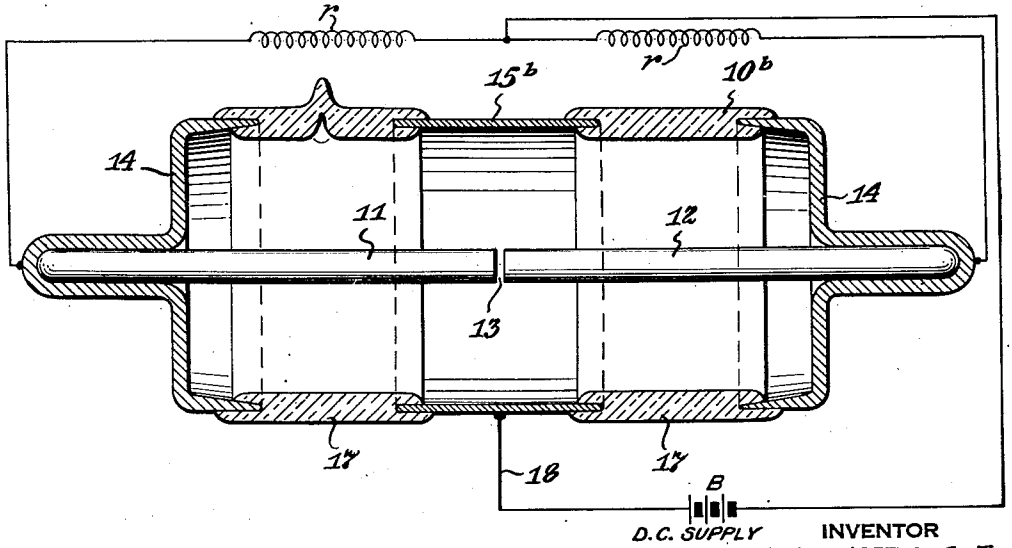


Fig. 3.



INVENTOR
W. W. WATROUS, JR.
BY
ATTORNEY

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SWITCH

Ward W. Watrous, Jr., East Orange, N. J., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

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5 Claims. (Cl. 250—27.5)

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This invention relates to switches for high frequency waves which automatically "shorts out" on the transmitted pulse and "opens" during the received pulse.

The invention has especial reference to employment with apparatus for location of aircraft or other objects by use of reflected waves, the switch comprising a spark gap between two electrodes within a gas-filled envelope. Such switches as heretofore made and used have had a relatively very short life, failing in the neighborhood of 60 hours' life. Inasmuch as failure may occur at a very critical moment, long and reliable operation is essential. Study of the prior art switches shows the usual type of failure is the result of bridging of the electrodes at the gap area by an accumulated "sputtering" of the electrode material. Other instances have shown the "sputtering" to have made a conductive path between electrodes upon the inner surface of the envelope.

Accordingly, the basic object of the present invention is to provide a switch which overcomes the deficiencies of the prior art.

Another object of the invention is to provide a switch having very long life.

A further object is to provide a switch wherein the sputtering is controlled and rendered harmless.

Again, an object of the invention is to provide an electrode and condition for attracting sputtered particles thereto.

Still other objects of the invention will appear to those skilled in the art as the description progresses, both by direct statement 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 perspective of my invention in one embodiment thereof;

Figure 2 is a similar view of a portion of a switch of the present invention, showing a different electrode structure; and

Figure 3 is a further modified construction of switch embodying the invention.

In the specific embodiment of the invention illustrated in said drawing, and for the moment referring more particularly to Figure 1, the reference numeral 10 designates an insulative envelope of appropriate size, shape and material, such as glass. Within the envelope are spaced electrodes 11, 12, shown in this instance, although not necessarily, as directly opposed axially alined pin type electrodes with the ends of the pins flat and in appropriate and parallel proximity to

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each other to provide a spark gap 13. The outer ends of the electrodes are suitably carried by and sealed with respect to the envelope such that electrical connections may be made thereto at the exterior of the envelope. As here shown, the outer ends of said electrodes are secured in thimbles 14 inner edges of which are sealed in the glass in approved manner.

Offset from the two said electrodes and opposite the gap 13, is a third electrode which for convenience will be termed an anode 15. As shown, said anode is a disc the plane of which is parallel to the axis of the spark-gap electrodes 11, 12. A high positive potential is applied between said anode and the spark-gap electrodes.

In the construction of Figure 2, except for said anode, the device is the same as that of Figure 1. However, the anode 15a of Figure 2, while also generally disc shaped and situated as in the previously described form, is of foraminous material. In both views, the envelope 10 is appropriately sealed with respect to a lead-in support 16 for the anode. A high positive potential, as before, is applied to this anode 15a.

In the construction shown in Figure 3, a cylindrical anode 15b is provided coaxial with the spark-gap electrodes 11, 12, said anode also constituting part of the envelope 10b. As shown, the thimbles 14 at the outer ends of the spark-gap electrodes seal with respect to a pair of glass or other insulative cylinders 17 which are coaxial with the electrodes and which are sealed at their inwardly directed edges to opposite ends of said cylindrical anode. Since the outer wall of the cylindrical anode 15b in this case is exposed to the exterior, circuit connection for applying the high positive potential thereto may be made by any suitable means as by soldering a lead wire 18 thereto.

In all instances shown and described, the envelope is preferably evacuated and refilled with a suitable gas, of which the various inert gases, such as nitrogen, argon, helium, neon, etc., are examples, as well as others of more active character, such as hydrogen. The gas employed is preferably at approximately atmospheric pressure. When the potential is sufficiently high to produce ionization, the gas within the envelope changes state, resulting in free electrons, negative ions and positive ions being produced. The electrons and negative ions attach themselves to particles of electrode material which sputter from the spark-gap electrodes. The result is that these particles take on a negative charge and are drawn to the so-called anode due to the action of the

electric field. The said anode accordingly acts as a collecting plate, it being located in each instance at a point remote from but opposite the spark-gap of the main electrodes. Where heretofore that accumulation had remained between and pyramided from one electrode to the other, it is, by the present invention not only drawn away from the spark gap, but is accumulated upon a metal part, namely, the so-called anode, where it is harmless. Likewise, while in the prior art much of the sputtered material roamed within the envelope and finally or immediately deposited on the glass wall, ultimately forming a short-circuit path between electrodes, it is controlled in accordance with the present invention and drawn to the anode where it remains and accordingly does not deposit on the glass. Shorting either across the spark gap or via the glass wall is thus definitely prevented.

It may be stated, by way of information in the use of the invention with promulgation and reception of radio or high frequency energy in the suggested employment as an automatic switch for detection of aircraft or other objects, that the radio frequency of the signal system and the D. C. potential applied between the electrodes and so-called anode must be, in effect, electrically separated. There are various modes of accomplishment of that desideratum and no attempt is here made to discuss circuit arrangements. Suffice it to say that the negative pole of the D. C. potential is to be applied to the two spark-gap electrodes through suitable connection, such as through a pair of reactors *r* of very high impedance to the direct current supply B, and the positive pole is applied to the anode. In instances of ultra high frequency, use may be made of a stub line of an odd number of quarter wave lengths connecting across the spark-gap terminals with a midpoint to ground and the ends of the line approaching infinity. Thus the midpoint may be used as one terminal of the D. C. supply to the two main electrodes without affecting the distribution of the radio frequency power in the main transmission line.

It may furthermore be here added that the so-called anode or third electrode, may be the control of "breakdown" across the main or spark-gap electrodes by adjusting the magnitude of the current between the electrodes and the anode or third electrode. This control will result in a greatly lowered "firing" potential and increased stability and reliability of the gap.

Since the various details of construction, as well as the precise relation and functioning of parts are subject to variation and change without departing from the inventive concept or scope of the invention, it is intended that all matter contained in the specification or illustrated in the drawing, shall be interpreted as exemplary and not in a limiting sense.

I claim:

1. A shorting switch for high frequency comprising a pair of electrodes aligned on a common axis with ends of said electrodes in proximity one to the other and providing a high frequency discharge gap therebetween, means mounting said electrodes electrically insulated from each other, a third electrode in parallelism to said axis of

the pair of electrodes and opposite said gap in a direction perpendicular to said axis, and an envelope including parts of all of said electrodes therein, said envelope containing an ionizable gas and said third electrode having a part exposed at the exterior of said envelope connected to a positive direct current potential with respect to one of said pair of electrodes for thereby maintaining an ionization of said gas and a conductive path for high frequency discharge between the electrodes of said pair of electrodes across said gap.

2. A protective means for a low power receiver line to which high power is applied, comprising a shorting switch to be connected across said line, said switch having a plurality of electrodes of which two are to be connected to said line, said switch having a third electrode, an envelope enclosing parts of said electrodes, and an ionizable gas in said envelope, all of said electrodes being spaced from each other, and a source of direct current potential providing positive and negative polarity with the negative polarity of said source connected to both of said two electrodes and with the positive polarity of said source connected to said third electrode for thereby maintaining ionized shorting path for high power across said two electrodes and the line.

3. A protective means for a low power receiver line to which high power is applied, comprising a shorting switch to be connected across said line, said switch having a plurality of electrodes of which two are to be connected to said line, and provide a spark gap therebetween for passing high power, said switch having a third electrode offset from and opposite said spark gap, an envelope enclosing parts of said electrodes, and an ionizable gas in said envelope, and a source of direct current potential providing positive and negative polarity with the negative polarity of said source connected to both of said two electrodes and with the positive polarity of said source connected to said third electrode for thereby maintaining ionized shorting path for high power across said two electrodes and the line.

4. A high-frequency switch comprising a pair of metal end caps having cylindrical flanges directed one toward the other, a cylindrical anode of substantially the same diameter as said flanges and having its opposite ends directed toward said flanges, glass cylinders interposed between said ends of the anode and the respective end flanges and sealed to each, and a pair of alined electrodes within said flanges, anode and glass cylinders and coaxial therewith.

5. A high-frequency switch comprising a pair of metal end caps having cylindrical flanges directed one toward the other, a cylindrical anode of substantially the same diameter as said flanges and having its opposite ends directed toward said flanges, glass cylinders interposed between said ends of the anode and the respective end flanges and sealed to each, and a pair of alined electrodes within said flanges, anode and glass cylinders and coaxial therewith, said end caps having axial and outwardly extending nipples receiving, supporting and sealing said pair of electrodes in place within said flanges, anode and glass cylinders.

WARD W. WATROUS, JR.