Jan. 5, 1960 J. E. JENNINGS 2,920,168

COAXIAL SWITCH

Filed Jan. 24, 1957

Fig. 1

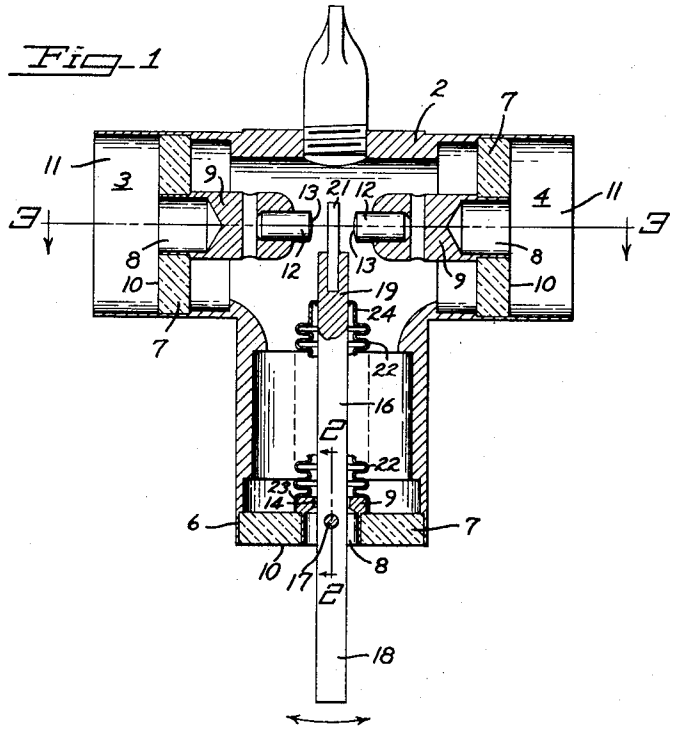


Fig. 2

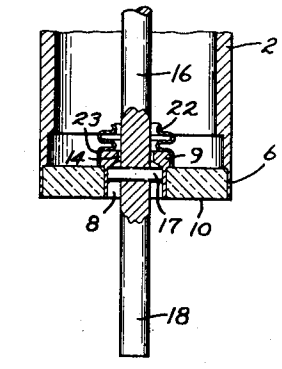
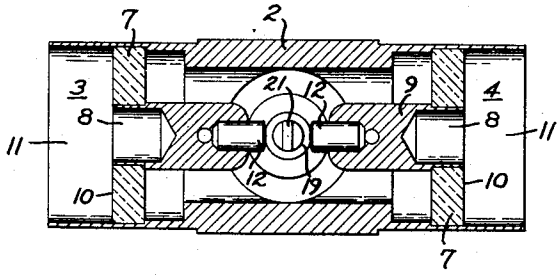


Fig. 3



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COAXIAL SWITCH

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8 Claims. (Cl. 200—144)

My invention relates to coaxial switches; and particularly to a coaxial switch arranged in a vacuumized envelope or housing.

One of the objects of my invention is the provision of a high efficiency vacuum coaxial switch having low radio frequency resistance and low inductance.

Another object is the provision of a miniature coaxial switch having a low operating inertia, requiring very little energy to operate the switch.

Still another object is the provision in an evacuated coaxial switch of ceramic disks forming an integral part of the vacuumized envelope thus forming a very strong and rugged seal in place of the more fragile conventional Housekeeper type or metal to glass seal.

A still further object is the provision of a coaxial switch in which closely spaced contacts and small bellows movement insures rapid actuation when desired and an exceptionally long life expectancy.

Another object is the provision of a coaxial switch in which the conductive part of the vacuumized envelope forms a continuous electrical and mechanical connecting link between the outer conductors of associated coaxial transmission lines.

A still further object is the provision of an evacuated coaxial switch in which at least two sets of inner and outer terminals are axially aligned and a third set is arranged substantially perpendicular thereto.

Still another object is the provision of a miniature coaxial switch having relatively few parts which may be substantially completely assembled and then brazed in one operation.

The invention possesses other objects some of which with the foregoing will be brought out in the following description of the invention. I do not limit myself to the showing made by the said description and the drawings, since I may adopt variant forms of the invention within the scope of the appended claims.

Referring to the drawings:

Fig. 1 is a half sectional view, partly in elevation, showing the internal structure of the switch.

Fig. 2 is a vertical sectional view of a portion of the switch. The plane of section is indicated by the line 2—2 of Fig. 1.

Fig. 3 is a horizontal sectional view taken in the plane indicated by the line 3—3 of Fig. 1.

All figures are drawn approximately twice actual size.

There has long been a need in the transmitting field for an efficient coaxial switch suitable for 50 to 70 ohm impedance operation. Such a switch to be practical should be extremely small and capable of filling power requirements of about 1 kw.

The switch should also possess the characteristic of being able to maintain at substantially a constant value, the surge impedance of the transmission lines with which it is to be used. The design preferably permits use of commercially available components arranged to provide simplicity of operation, high efficiency and low manufacturing costs.

The switch of my invention possesses all of these advantages in addition to a long life expectancy, low radio frequency resistance and low inductance. My switch is applicable to solve many different switching needs such as a transmit-receive switch, a transfer switch from one supply to another, an off-on switch where one side is used as a "crowbar," a high-low switch for A.C. or D.C. applications, a changeover switch between two antennas, two transmitters or two receivers, a keying switch where the receiver is disabled when the key is in transmit position, and as a transfer switch between an antenna and a dummy load.

Until quite recently, switching of this type was done in air or in an enclosed area with an air atmosphere. In a few instances expensive switches utilized hermetic envelopes into which a non-oxidizing atmosphere was introduced. Problems such as arcing, contaminants within the envelope and rapidly increasing resistance through the switch still persist in many of these conventional switches, and it is to eliminate these disadvantages that my switch has been designed.

Broadly, the coaxial switch of my invention comprises a hollow evacuated T-shaped copper housing having a cylindrical cross-section and providing integral outer terminals for connection to the outer conductors of associated coaxial transmission lines. Each of the outer terminal ends of the T-shaped housing is hermetically sealed by a dielectric annulus integrally and hermetically interposed between each outer terminal and a coaxial inner terminal brazed into the inner periphery of the annulus.

Each of the inner terminals is adapted to be mechanically and conductively connected to the inner conductor of an associated coaxial transmission line. Within the housing, two of the inner terminals are mutually extending about a common axis and each is provided with an integral contact point spaced from and axially aligned with the other. The third inner terminal pivotally supports an actuator stem having a contact point on its inner end which is selectively engageable with one or the other of the two axially aligned contact points. An expansible bellows is hermetically interposed within the housing between the stem and its associated inner terminal so as to permit lateral reciprocation of the stem while providing a hermetic seal thereabout.

Evacuation of the envelope through appropriate tubulation removes the oxidizing atmosphere and contaminants from within the envelope, thus insuring a constant surge impedance through the switch, and reducing arcing to a minimum.

In more specific terms, the coaxial switch of my invention comprises a hollow evacuated envelope formed by a T-shaped copper housing **2**, having hollow outer cylindrical terminals **3**, **4** and **6**, corresponding respectively to the axially aligned left and right ends of the crossbar of the T and to the perpendicular stem end thereof.

Each of the hollow cylindrical outer terminals is hermetically closed by a ceramic annulus **7**, having its outer periphery brazed within the hollow cylindrical terminal, and its inner periphery brazed about the hollow terminal end **8** of an inner inwardly extending conductor **9**. Each inner terminal is concentrically positioned by the ceramic annulus with regard to its associated outer terminal, and preferably terminates outside the envelope flush with the outer face **10** of the ceramic annulus. It will be noted that each of outer terminals **3** and **4** extends beyond its associated ceramic annulus in a guide portion **11**, useful when the switch is connected into a coaxial transmission line. Preferably, the outer terminal walls **3**, **4** and **6** and the hollow inner terminal ends **8**, possess a cross-sectional thinness sufficient to maintain

a hermetically tight integral union with the ceramic annulus during expansion and contraction of the parts.

Two of the inner terminal conductors 9 are mutually extending and coaxially aligned with outer terminals 3 and 4. The inner end of each is provided with a contact point 12 integrally embedded in the conductor and extending axially toward the other but terminating at a point spaced therefrom. Each of the contact points is conveniently formed from a short length of tungsten rod, the inner end of which has been ground off to provide a slightly convex surface 13.

The third inner terminal conductor 9, coaxially associated with outer terminal 6, extends inwardly of the envelope at right angles to the other two, and is provided with a central bore 14 through which a conductive metallic actuating stem or rod 16 projects. The stem is pivoted on journal pin 17 extending across the inner diameter of the terminal and brazed at its ends thereto. A portion 18 of the stem preferably extends outwardly and is adapted to be manipulated so as to pivot the stem on its journal.

The inner free end 19 of the stem projects into the envelope perpendicular to the contact points 12, and terminates at a point laterally spaced therefrom. A flat tungsten contact point 21, integrally mounted on the inner end of the stem, projects therefrom so as to be interposed midway between the convex end surfaces 13 of the contact points 12. Reciprocation of the outer end 18 of the stem in the directions indicated by the arrow in Fig. 1 will thus alternately swing the contact point 21 into and out of engagement with the convex ends of the contact points.

Integrally and hermetically interposed between the stem 16 and the inner end portion of the inner conductor 9 is a flexible metallic bellows 22. The bellows is concentrically disposed about the stem, with its outer end 23 brazed about the central conductor, and its inner end 24 brazed about the stem adjacent its inner free end. The bellows thus performs the multiple functions of sealing the envelope while permitting reciprocation of the actuating stem; it serves as an integral and continuous conductor between the inner terminal 8 and the stem to maintain a constant surge impedance through the switch; and because of its inherent resilience, it tends to return to a neutral position after flexure in which the contact point 21 lies interposed midway between the contact points 12. It will be noted that the amount of flexure required of the bellows by manipulation of the actuating stem is very slight. The bellows convolutions near the outer end 23 move only a small increment, with the amount of flexure increasing only slightly adjacent the inner end 24. This small amount of flexure is reflected by an extremely long life.

As readily seen, the design of the switch lends itself to the assembly of almost all contiguous parts, and their subsequent integration by brazing into a composite unitary structure possessing the requisite characteristics of low radio frequency resistance and low inductance. Evacuation of the hermetically sealed envelope through tubulation 26 insures the withdrawal of oxidizing agents and contaminants so that contact resistance will remain substantially constant for the life of the switch.

In use, the switch is interposed in a coaxial transmission line rated at the same surge impedance as the switch rating. The outer terminals 3, 4 and 6 are adapted to form a close slip fit on the outer conductor of the transmission line, and if desirable, the joint may be clamped or brazed to insure electrical continuity and rigidity.

I claim:

1. A vacuum switch comprising a T-shaped housing having the hollow stem of the T substantially perpendicular to the hollow bar thereof, a metallized ceramic annulus brazed into each end of the housing to form a hermetically tight joint therewith, aligned conductive inner terminals axially arranged in the hollow bar with each inner terminal brazed at its outer end into the opening of an annulus to seal hermetically the associated end of the housing and its inner end constituting a contact, an other inner terminal brazed into the opening of the stem annulus, a movable contact stem pivotally mounted on said other inner terminal and extending from outside the housing to adjacent the aligned inner terminals, a contact point conductively mounted on the movable stem and extending between the inner contact ends of the aligned inner terminals to engage selectively with either when the stem is moved, and a flexible bellows integrally interposed between the movable stem and said other inner terminal to seal hermetically the associated end of the housing.

2. A vacuum switch in accordance with claim 1, in which a metal tubulation is arranged in a wall of the housing.

3. A vacuum switch in accordance with claim 1, in which one of the ends of the housing has an internal annular shoulder against which the ceramic annulus is pressed by atmospheric pressure, the housing wall within which the annulus is brazed being reduced to a thinness sufficient to maintain a hermetically tight integral union with the metallized face of the annulus during expansion and contraction of the parts.

4. A vacuum switch in accordance with claim 1, in which said other inner terminal has a cylindical bottom end extending into the hollow stem of the housing and about which the adjacent end of the bellows is brazed.

5. A vacuum switch in accordance with claim 1, in which each inner terminal is provided with a tubular portion adapted to be brazed within the opening of an associated ceramic annulus, said tubular portion having a cross-sectional thinness sufficient to maintain a hermetically tight integral union with the annulus during expansion and contraction of the parts.

6. A switch for coaxial transmission lines comprising a unitary hollow conductive housing having a plurality of integral tubular outer terminal portions, each having a centrally disposed longitudinal axis, an inner terminal member coaxially arranged along the longitudinal axis of and within each of said outer terminal portions and extending into said housing, an adjacent pair of said inner terminal members having ends within said housing spaced from one another, a third of said inner terminal members having a contact end disposed between said spaced ends of said adjacent pair of inner terminal members, a metallized ceramic means brazed in each of said outer terminal portions having one of said adjacent inner terminal members disposed therein, said metallized ceramic means each surrounding and supporting the inner terminal member therein and engaging said outer and inner terminal members to provide a hermetically-tight sealed joint, a metallized ceramic means brazed in said outer terminal portion having said third inner terminal member disposed therein, said last-named metallized ceramic means engaging its outer terminal portion to provide a hermetically-tight sealed joint therewith and being provided with an opening through which said third inner terminal member extends, a pivot means supported by said third inner terminal member and having a movable contact stem for reciprocating movement between said spaced inner terminal member ends, and a flexible, resilient sealing means engaging said pivot supporting inner terminal and said movable contact stem to provide hermetically-tight sealed joints therebetween and to maintain said movable contact stem normally out of contact with said spaced inner terminal member ends.

7. A vacuum switch comprising a unitary hollow conductive housing having a plurality of integral tubular outer terminal portions extending outwardly as appendages, one of said integral tubular outer terminal portions disposed as a part of said housing to extend outwardly therefrom and spaced between a pair of said integral tubular portions, a metallized ceramic annulus brazed in

each of said tubular outer terminal portions adjacent the outer ends thereof to form a hermetically tight joint therewith, conductive inner terminals axially arranged in said pair of integral tubular outer portions with each inner terminal attached at its outer end into the opening of an annulus to seal hermetically the associated end of the tubular outer terminal portion, the inner end of each conductive inner terminal being spaced from the other and constituting a contact, another inner terminal hermetically attached into the opening of the annulus in said tubular outer terminal portion that is disposed between said pair of integral tubular outer portions, a movable contact stem pivotally mounted on said other inner terminal and extending from outside the housing to adjacent the spaced apart inner end contacts on said inner terminals, a contact point conductively mounted on the movable stem and extending between the said spaced apart inner end contacts on said inner terminals to engage selectively with either when the stem is moved, and a flexible, resilient sealing means engaging said pivot supporting inner terminal and said movable contact stem to provide hermetically-tight sealed joints therebetween and to maintain said movable stem normally out of contact with said spaced apart inner end contacts on said inner terminals.

8. A switch for coaxial transmission lines comprising a unitary hollow conductive housing having a plurality of integral tubular outer terminal portions, each having a centrally disposed longitudinal axis, an inner terminal

member coaxially arranged along the longitudinal axis of and within each of said outer terminal portions and extending into said housing, an adjacent pair of said inner terminal members having ends within said housing spaced from one another, a metallized ceramic means brazed in each of said outer terminal portions having one of said adjacent inner terminal members disposed therein, said metallized ceramic means each surrounding and supporting the inner terminal member therein and engaging said outer and inner terminal members to provide a hermetically-tight sealed joint, a pivot means supported by one of said adjacent inner terminal members and having a movable contact stem for reciprocating movement to connect or disconnect the other adjacent spaced inner terminal member, and a flexible resilient sealing means engaging said pivot supporting inner terminal and said movable contact stem to provide hermetically-tight sealed joints therebetween and to maintain said movable contact stem normally out of contact with said other adjacent spaced inner terminal member.

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