

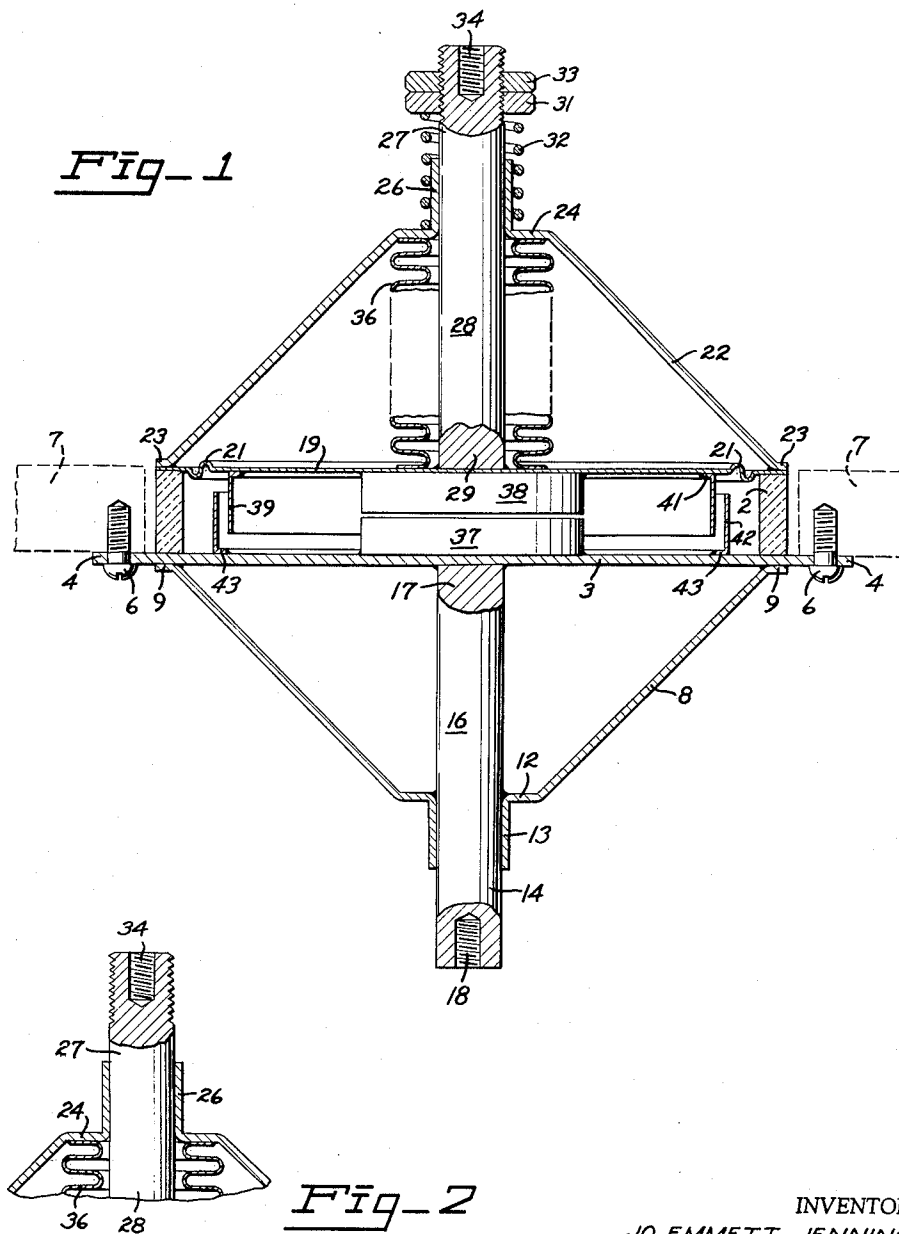
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J. E. JENNINGS

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VACUUM SWITCH

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INVENTOR.
JO EMMETT JENNINGS

BY *Charles S. Evans*

his ATTORNEY

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VACUUM SWITCH

Jo Emmett Jennings, San Jose, Calif., assignor to Jennings Radio Manufacturing Corporation, San Jose, Calif., a corporation of California

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5 Claims. (Cl. 200—144)

My invention relates to vacuum switches, and particularly to a low voltage vacuum switch having high current carrying capacity.

One of the objects of my invention is the provision of a vacuum switch capable of being oven-brazed in one operation.

Another object of the invention is the provision of a vacuum switch incorporating components easily fabricated and capable of accurate assembly by mass production methods.

Still another object of the invention is the provision of a vacuum switch highly resistant to humid and corrosive atmospheres and unaffected by frequent and extreme temperature variations.

A still further object of the invention is the provision of a vacuum switch useful where a minimum space requirement and low inductance are important factors.

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 claim.

Referring to the drawing:

Fig. 1 is a vertical half sectional view of the switch, showing a normally open embodiment thereof. Portions of the switch are shown in elevation.

Fig. 2 is a fragmentary sectional view partly in elevation, showing the relationship of parts on the movable end of a normally closed version of the switch.

Both views are drawn approximately actual size.

Broadly considered, the vacuum switch of my invention comprises an evacuated envelope formed by a cylindrical dielectric shell closed at each opposite end by conductive metallic plates or end cap structures hermetically brazed to the metallized ends of the dielectric shell and constituting terminal electrodes of the switch. Each end cap structure conductively supports a switch contact within the envelope in axial alignment with the opposed contact. To effect selective engagement and disengagement of the contacts, one of the end cap structures is axially displaceable from outside the envelope by actuator means connected thereto. In the normally open embodiment of the invention illustrated, means are interposed between the actuator means and the envelope to retain the contacts in open position against atmospheric pressure.

In greater detail, and referring now to the drawing, the vacuum switch of my invention comprises a hollow cylindrical dielectric shell 2, preferably of ceramic of relatively large diameter, varying for different size switches from a minimum of about three inches in diameter to eight or ten inches. To meet minimum space requirements the length of the dielectric shell is preferably kept to a minimum, being determined by the maximum external flash-over voltage which it is desired the envelope should safely withstand.

The dielectric shell is hermetically sealed at opposite

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ends by fixed and mobile metallic end plate or end cap structure hermetically brazed across the open metallized ends of the dielectric shell. The fixed end cap structure comprises a relatively thick and rigid conductive circular end plate 3, arranged concentrically across and brazed to the lower metallized end of the dielectric shell 2. An outer peripheral portion of the end plate extends beyond the periphery of the dielectric shell and constitutes an annular mounting flange 4 apertured at regular intervals thereabout to receive mounting screws 6, which mount the device in a support panel 7, shown in dash lines in Fig. 1.

To stiffen the end plate and render it less likely to deflect under atmospheric pressure, a conical metallic shell 8 is concentrically arranged thereon on the side opposite the dielectric shell. A radially extending flange 9 on the base of the conical shell is hermetically brazed to the plate 3. The apex end of the conical shell, spaced below the plate, terminates in a radially inwardly extending annular shoulder 12 integral at its inner periphery with a cylindrical flange 13 concentric with the end plate 3.

The flange 13 forms a guide for and rigidly supports the outer end portion 14 of a terminal rod 16 brazed therein, the inner end 17 of which abuts the plate 3 and is brazed thereto. A threaded bore 18 in the outer end of the terminal rod provides means for connecting the rod into a circuit. It will thus be seen that an extremely strong end cap structure is formed, possessing the requisite rigidity to withstand the nearly 1200 pounds of atmospheric pressure which would be imposed on an envelope 10" in diameter. Additionally, the conical shell and central terminal rod, being integrally united to the plate, provide a continuous path for effectively conducting heat away from the plate 3.

At the other end of the envelope, the displaceable end plate or end cap structure comprises a flexible conductive diaphragm 19 extending across the metallized end of the dielectric shell and having its peripheral edge portion hermetically brazed thereto. The diaphragm may vary in thickness, depending on the diameter and flexibility desired. In the size switch illustrated, a diaphragm having a .005" thickness will provide adequate flexibility. For added flexibility and increased life expectancy, a pair of concentric convolutions 21 are formed in the diaphragm adjacent its outer periphery and within the shell 2.

To provide controlled displacement of the diaphragm, means are provided for retaining the diaphragm in an outwardly extended condition against atmospheric pressure. Mounted on the envelope on the side of the diaphragm opposite the dielectric shell is a conical metallic shell 22 having a radial base flange 23 hermetically brazed to the diaphragm. The conical shell extends upwardly and terminates in a radially inwardly extending horizontal shoulder 24 integral at its inner periphery with a cylindrical bearing flange 26 concentric with the diaphragm. The bearing flange slidably guides and supports the outer end portion 27 of a terminal rod 28, the lower end 29 of which is brazed to the central portion of the diaphragm. The outer end portion of the terminal rod beyond the cylindrical bearing flange 26 is externally threaded to receive a nut 31 adjustable to increase or decrease the tension in coil compression spring 32, interposed between the nut and the shoulder 24. A lock nut 33 jammed against nut 31 retains that nut in adjusted position. As in the terminal rod 16, a threaded bore 34 provides a convenient means for connecting the switch into a circuit.

It will be seen that atmospheric pressure pressing inwardly on the diaphragm will tend to pull the terminal rod 28 downwardly into the conical shell. This tendency is resisted by tension in the spring 32, which is adjusted by nut 31 to flex the diaphragm outwardly against the pressure of the atmosphere. To reduce the

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total amount of atmospheric pressure exerted on the diaphragm, an expansible metallic bellows 36 is integrally and hermetically interposed between the shoulder 24 of conical shell 22 and the central portion of the diaphragm. The bellows surrounds the inner end of the terminal rod 28 and reduces to the effective cross-sectional area of the bellows interior, the area of the diaphragm against which the atmosphere will exert a force. It thus becomes apparent that the size of the spring 32 required to retain the diaphragm in extended position is materially reduced, resulting in a saving in the initial cost of the implement, and facilitating actuation thereof. Another advantage of the bellows is that it forms a continuous electrically and thermally conductive path between the diaphragm and the apex end of the conical shell, thus increasing the current carrying capacity of the switch and increasing the efficiency with which heat is conducted away from the diaphragm.

Mounted within the chamber or space between plate 3 and diaphragm 19 is a pair of opposed axially aligned contacts 37 and 38, conveniently comprised of cylindrical tungsten wafers. The fixed contact 37 is concentrically arranged and brazed to the plate 3, while the contact 38 is concentrically arranged and brazed to the diaphragm 19 in opposed relation to the fixed contact. The maximum spacing between the contacts when open will vary with the size of the implement, the voltage breakdown and the amount of current being handled. Successful results have been obtained with various spacings between .010" and .0125". Movement of the actuator stem 28 inwardly by means (not shown) attached to the outer end thereof will thus effect rapid closing of the contacts 37 and 38. Spring 32 will effect opening of the contacts upon removal of the actuating force from the rod 28. It will of course be obvious, as illustrated in Fig. 2, that removal of the spring 32 will transform the switch into a normally closed type, held closed by atmospheric pressure.

To prevent vaporized tungsten from the contacts from condensing on the interior surface of the dielectric shell and thus, with time, build up an undesirable conductive path between the end cap structures, shield means are provided interposed between the contacts and the dielectric shell. Mounted on the diaphragm within the envelope and adjacent the corrugations 21, is a cylindrical metallic shell 39 having at one end a base flange 41 brazed to the diaphragm. The other free end of the shell 39 is spaced a short distance from the plate 3, so that the shell effectively intercepts and provides a surface on which tungsten vapor may condense. A second metallic cylindrical shell 42 concentric with shell 39, and having at one end a flange 43 brazed to the plate 3, and spaced at its free end from the diaphragm, insures that tungsten vapor will be intercepted and condensed before reaching the dielectric shell.

It will be apparent from the drawing that either or both plate 3 and diaphragm 19 may be imperforate as shown with only the chamber therebetween evacuated. However, if desired, the space between conical shell 8 and plate 3, and conical shell 22 and the diaphragm 19 may also be evacuated and the plate 3 and diaphragm 19 perforated so that the entire implement is evacuated.

Evacuation of the device is preferably effected by furnace brazing the entire implement in a vacuum at high temperatures so that fabrication and evacuation is carried out in substantially one operation. When the hermetically brazed device is removed from the vacuum brazing furnace and permitted to cool, a high vacuum within the envelope will result.

I claim:

1. A vacuum switch comprising an evacuated envelope symmetrical about a longitudinal axis and including a

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dielectric shell hermetically sealed at opposite ends by metallic end cap structures constituting terminal electrodes, at least one of said metallic end structures including a conical shell having its base hermetically united integrally to said dielectric shell, a first contact within the envelope fixed on one of the end cap structures, a second contact within the envelope axially aligned with said first contact and movably supported on the other end cap structure for movement along the axis of said shell into and out of engagement with said first contact, and actuator means operatively connected to said movable contact to effect movement thereof to selectively engage or disengage said contacts.

2. The combination according to claim 1, in which said movable contact is movably supported on said conical shell.

3. The combination according to claim 1, in which said movable contact is movably supported on said conical shell, and flexible conductive means are integrally interposed between said movable contact and the conical shell.

4. A vacuum switch comprising an evacuated envelope including a cylindrical dielectric shell hermetically sealed at opposite ends by metallic end plates, one of said plates being axially displaceable, a first contact within the envelope mounted on said displaceable end plate, a second contact within the envelope mounted on the other end plate, bearing means rigidly fixed on the envelope, actuator means operatively connected to said displaceable end plate and slidably supported on said bearing means to effect displacement of said displaceable end plate to selectively engage or disengage said contacts, and a flexible metallic bellows hermetically interposed between the displaceable end plate and said bearing means.

5. In a vacuum switch having an evacuated envelope and a multiple contact mounted on a displaceable diaphragm within said envelope for movement toward and away from a fixed contact, an elongated actuating rod fixedly secured at one end to said diaphragm and connected at its other end to means for actuating the same, bearing means rigidly fixed on said envelope and slidably receiving said rod therethrough, and a flexible metallic bellows hermetically interposed between said diaphragm and said bearing means.

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