

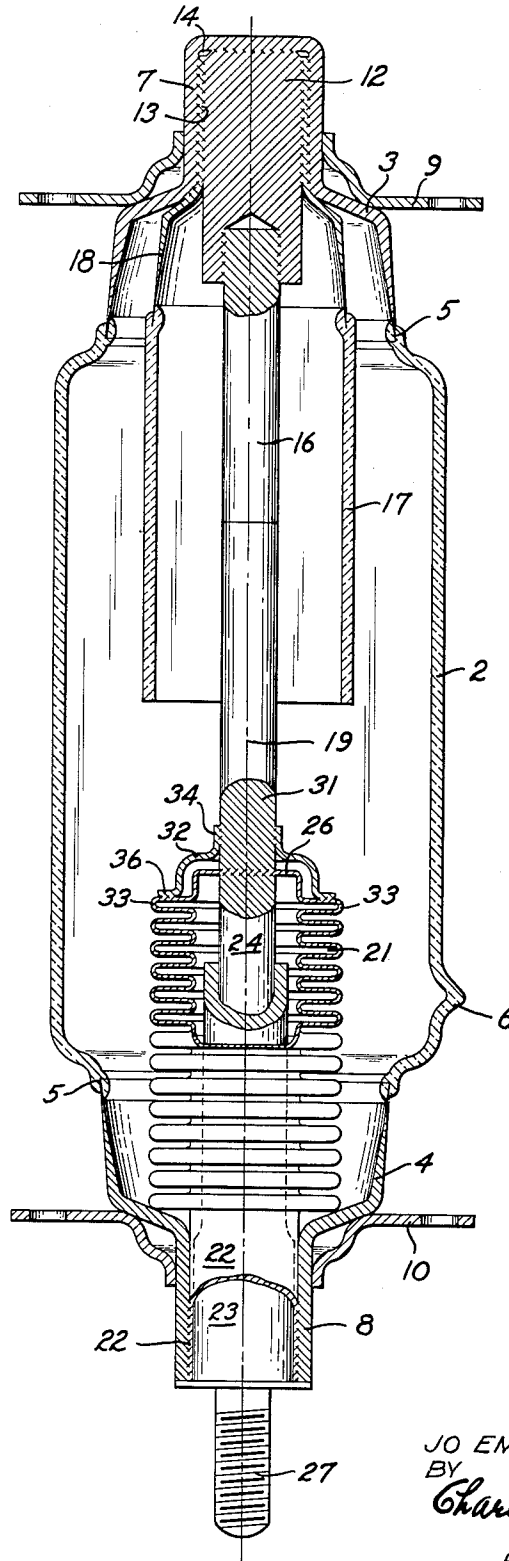
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VACUUM SWITCH

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VACUUM SWITCH

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3 Claims. (Cl. 200-144)

My invention relates to vacuum switches; and the principal object of the invention is the provision in a vacuum switch of contact points surrounded by a vapor condensing non-metallic shield.

Another object of the invention is the provision in a vacuum switch of contact points surrounded by a vitreous shield.

Another object of the invention is the provision of an improved mounting means for a shielding tube in a vacuum switch.

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.

The figure of the drawing is an elevation, partly in vertical section, of my vacuum switch and non-metallic shield.

In my copending application, Serial Number 317,184 filed October 28, 1952, I have explained in detail the structure, advantages and uses of a vacuum switch having a metallic shield surrounding the tungsten contact points.

The present application is confined to a modification of my said earlier invention, in which modification a non-metallic shield and mounting means is included. The internal operating structure of the switch is the same as explained in connection with my said copending application.

My vacuum switch comprises a vacuumized envelope in which metallic contact rods, one fixed and the other movable, are arranged in axial alignment. The interposition of a flexible metallic bellows between the mobile rod and the envelope wall permits operative movement of the mobile rod by means external to the envelope.

Since normal atmospheric pressure tends to expand the bellows into the envelope, the atmospheric pressure may be utilized to hold the contact points together in normally closed position, and to speedily close the gap between them upon release of separating pressure applied externally when the circuit through the switch is to be broken.

The range of movement of the mobile contact rod is very small and extremely rapid. With only $\frac{1}{8}$ " of separation between the contact points, the stand-off value exceeds 100,000 volts. A switch such as illustrated in the drawings will safely handle voltages up to 50,000 and is capable of conducting continuously current volumes up to 50 amperes.

Although arcing between the contact points is at a minimum in the vacuumized envelope, some vaporization of the metal contact points occurs. If this vapor is allowed to condense and gradually build up on the inside surface of the envelope, it forms a conducting path between the inside terminals, thus shorting the contact points and seriously limiting the useful life of the unit. My invention provides a surface on which substantially all of the vaporized metal, condenses without providing a conducting path

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around the contact rods, so that the useful life of the device is extended indefinitely.

In the drawing, I have shown a switch designed for use in a normally closed circuit where the pressure of the atmosphere tends to hold the contact rods together, and reestablishes contact after it has been broken.

In detail, my switch comprises a glass shell 2, closed at the ends with copper caps 3 and 4, joined to the shell by a conventional Housekeeper seal 5. The completed envelope is evacuated in the usual way and sealed off at the tabulation 6.

The caps constitute the external terminals of the switch; and also provide lugs 7 and 8 respectively by which the implement may be mounted in suitable clips, or which are utilized in mounting the switch in supporting flanges 9 and 10, usually but not necessarily in a horizontal position.

The lug 7 is filled with a copper plug 12 surrounded by the cylindrical sleeve 13; lug, sleeve and plug being joined together by brazing. A ring of silver solder is placed in the annular recess 14 at the end of the plug before the parts are assembled, so that when heated the three parts are integrally united into one continuous metal structure.

Seated in the end of the plug and integrally united therewith by brazing, is a relatively short, preferably tungsten, rod 16, forming one of the contact points of the switch.

Spaced from and surrounding the rod and extending well beyond its end is a cylindrical tube or shield 17, preferably of glass, but other suitable non-metallic materials may be used.

If of glass the tube is conveniently mounted by means of the Housekeeper seal technique on the feathered edge of the flange 18, which is belled out from the inner end of the collar 13. All of the above fixed-end cap structure of terminal cap, collar, plug, contact rod and tube are concentric about the long axis 19 of the switch structure.

At the opposite end of the glass shell 2, the copper terminal cap 4 provides a mounting for the mobile contact rod and the bellows by which the envelope is closed and which permits movement of the rod without breaking the extremely high vacuum in the envelope.

The bellows 21 preferably of bronze terminates at one end in a cylindrical sleeve 22, fitting snugly into the cylindrical base flange 8 of the cap 4. Fitting snugly into the inside of the sleeve is a plug 23, extending well up into the bellows and providing a long journal bearing within which the mobile contact rod 24 preferably of stainless steel may slide. Base flange, sleeve and plug are brazed together so that the three are integrally united.

The bellows is closed at its inner end by the end wall 26, the rod 24 extending to the wall and being brazed to it with high temperature silver solder fusing at about 1000° C. The bellows folds are thus interposed between the rod 24 and the cap 4, and permit limited axial movement of the rod within its bearing plug without injury to the hermetic sealing of the envelope.

The outer end of the rod 24 is provided with threads 27 for connection to an operating means which may be a solenoid or other suitable means.

Because of the relative costs of steel and tungsten and for other reasons, the rod 24 is made of steel up to its union with the end wall of the bellows. To the outside of the bellows a tungsten rod 31 is brazed with high melting point silver solder in axial alignment with rod 24 so that the two are essentially one since they are integrally united through the bronze end wall of the bellows. The tungsten end of the rod extends into the open end of the tube 17, and into contact with the end of the fixed contact rod 16.

In order to connect the rod 24 more closely to the folds of the bellows and avoid a loss of motion because of

flexibility in the end wall 26, a flanged nickel cap 32 is brazed over the end fold 33 of the bellows close to its periphery and also to the rod. Besides rigidly connecting the rod to the bellows, the cap facilitates the transmission of heat from the tungsten rod to the bellows and cap, and also provides a greater area for current flow. Since these brazing operations cannot all be accomplished at one time, the flange 34 of the cap is brazed to the rod with high melting point (about 1000° C.) silver solder, and the periphery 36 of the cap is brazed to the end fold 33 of the bellows with a silver solder melting at about 700° C., so that by performing this operation last, the earlier brazed connections are not imperiled.

Like the fixed end structure, the mobile end of the terminal cap, bellows, bearing plug, rod and stiffening cap are concentrically arranged about the long axis 19 and integrally united into one continuous metallic body. The sizes and relation of parts are such that when the envelope is fully evacuated, the two contact rods are pressed together with the full force of atmospheric pressure. Under operating conditions, and when energized, the solenoid (or other operator) pulls the rod 24 outwardly, perhaps 1/8", thus separating the contacting points of the two rods and breaking the circuit.

Since the atmospheric pressure against the inside of the bellows is substantially constant, the contact points are again engaged when the solenoid is deenergized, to re-establish the circuit through the contact rods.

The interruption of the circuit in the vacuumized envelope is attended with a minimum of arcing between the separating tungsten points of contact. This minimum is strongly influenced by the speed of separation; and use of a properly designed solenoid effects an almost instantaneous break and resultingly, there is a very minimum of sparking. However, it is impossible to wholly prevent all arcing and to the extent it occurs, tungsten is vaporized. Without a baffle or barrier means of some kind, the vaporized metal condenses on the inside surface of the glass shell, and builds up thereon a conducting layer which eventually shorts across the rods, and of course ruins the switch.

I prevent this result, although I cannot wholly prevent the cause, by surrounding the arcing points with the glass baffle or shield tube 17. The tube extends a substantial distance on each side of the break point where arcing occurs; and the vaporized tungsten is caught by and deposited on the inside surface of the tube. Experiments have shown that with my baffle tube in place no significant quantity of metal vapor escapes from the tube into the interior of the envelope, and that no appreciable deposit on the interior surface of the glass envelope occurs to create a short circuiting film thereon.

I have found that the glass tube baffle or shield is more efficient than a metal one, and allows greater overload capabilities of the switch.

Copper is particularly suitable for the end cap struc-

tures since electric current is to be conducted, as well as the heat from the contact points carried to the external parts of the unit where it is dissipated into the air. The copper or bronze bellows which is in parallel with the rod 24 is a major conductor for both current and heat; and the glass baffle tube 17, also functions in helping to dissipate heat generated at the contact points.

Tungsten is preferred for the contact rods or the major proportion thereof because it has the highest melting point and the lowest vapor pressure of available refractory metals, in addition to a satisfactory thermal and low electrical resistance. Also because in a vacuum, contact resistance is lower since no oxides are present on the contact surface. The external portion 24 of the contact rod is of course exposed to the influence of the atmosphere with possibly a corrosive gas component. It may therefore be made of stainless steel or bronze.

Instead of a glass shield, the tube may be made of other non-metallic refractory or heat resistant materials, among them porcelain or other ceramic compounds, stealite, aluminum oxide, and certain of the plastics from the silicones or phenolic group.

I claim:

1. In a vacuum switch, a vacuumized envelope having a metal end cap constituting a terminal, a metallic cylinder integrally united to the end cap on the interior thereof and extending into the envelope as a circular flange, a metallic plug integrally united to the cylinder and the end cap on the interior thereof and extending into the envelope within the flange, a contact rod fixed in the inward end of the plug, and a vitreous shield enclosing the contact rod and extending past its inward end and mounted on said flange.

2. In a vacuum switch, a vacuumized envelope having a metal end cap constituting a terminal, a contact rod integral with the terminal and extending into the envelope, a circular metallic flange integral with the end cap and extending into the envelope around and spaced from the contact rod, and a vitreous shield supported only on said flange and spaced from and enclosing the contact rod and extending past its inward end.

3. In a vacuum switch, a vacuumized envelope having a glass shell closed at one end by a metal terminal having a free cylindrical outer stud end and on its inner end three spaced concentric flanges, the outer flange joined hermetically to the glass shell and forming a part of the envelope, a contact rod integrally connected within the inner flange, and a cylindrical glass shield having open ends mounted on the intermediate flange and extending past the free end of the contact rod.

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