

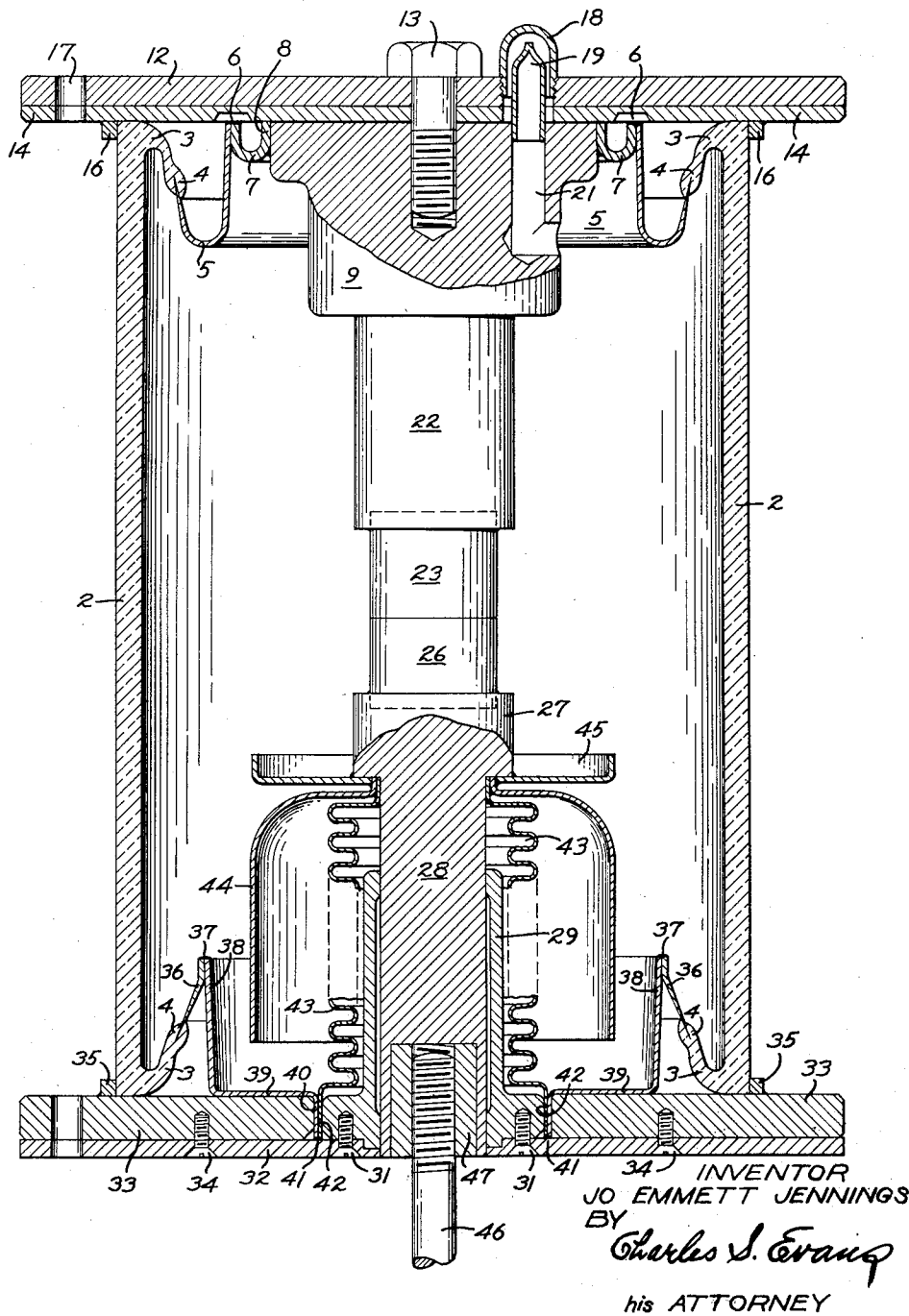
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VACUUMIZED ELECTRIC SWITCH

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VACUUMIZED ELECTRIC SWITCH

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8 Claims. (Cl. 200—144)

My invention relates to vacuum switches and especially to such switches of large diameter and very large capacity.

One of the principal objects of the invention is the provision of a vacuumized switch having an envelope large enough to hold the heavy conductive structure and contacts required for carrying currents up to 10,000 amperes or more.

With the development and use of electric power, there has been demand for larger and larger vacuum switches to handle the increasing current loads. Expanding the diameter and capacity of vacuum switches has been severely hampered by the inherent weakness of the metal-to-glass or conventional Housekeeper's seal. Any increase in size of a vacuumized shell or envelope results in a directly proportional increase in total pressure exerted by the atmosphere on all exposed surfaces of the envelope; and on an eight inch generally cylindrical evacuated envelope, the pressure tending to crush in each end amounts to more than 700 lbs. This is greatly in excess of pressures which can be borne by switches having conventional metal-to-glass unions or seals.

In addition to stresses imposed by atmospheric pressure, the conventional seal must carry stresses imposed by the weight, sometimes considerable, of operative parts mounted on the ends, and also, the shock of closing contacts and the outward jerk of the opening contacts.

The primary object of my invention therefore is to provide means whereby a large vacuumized nonconductive cylindrical shell can be closed hermetically at its ends, and having strength amply sufficient to carry the heavy loads imposed by its size.

Because of the excellence of the conventional metal-to-glass seal under ideal conditions of light loading, it also is an object of my invention to utilize the metal-to-glass seal in cooperative relation with a heavy load bearing structure so that the metal-to-glass joint performs its primary function of hermetic sealing, but is relieved of destructive pressures, torsions and other stresses, which tend to cause failure.

Because of the high cost of electrical implements of this character another object of my invention is the provision of a vacuumized envelope which can readily be opened for replacement or repair, then resealed and exhausted for further service.

Another object of my invention is the provision of an hermetic sealing structure for the ends of an evacuated non-conductive shell in which atmospheric pressure is utilized to rigidly secure the ends in permanent assembly.

Since in the conventional copper-to-glass seal, the metal is exposed directly to the oxidizing atmosphere during the high temperatures of the baking out period, and is thus subject to thinning and softening to a degree which may cause a later failure of the seal, it has also been an object of my invention to provide a closing and sealing structure embodying a metal-to-glass seal to which heavier parts give protection, materially reducing the possibility of injury during prolonged exposure to high temperature.

Other objects will be brought out in the following de-

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scription of the invention. I do not limit myself to the showing made by said description and the drawings, since I may use variant forms of the invention within the scope of the appended claims.

With reference to the drawing, the single figure is a half sectional view of a switch embodying my invention. The scale is approximately full size.

In broadly descriptive terms, the switch of my invention and as illustrated in the drawing comprises a large glass cylindrical shell closed at each end by a heavy cover plate. Within the shell and cover plate at each end, a relatively thin annular copper membrane is joined hermetically to the shell in a conventional metal-to-glass seal.

At the fixed contact end of the switch, the relatively large central aperture of the annular membrane is closed by a mounting block, mechanically fixed to and supported by the cover plate at that end. The fixed contact of the switch is rigidly mounted on the mounting block. Thus atmospheric pressure on the fixed contact end of the switch is imposed only on the exposed area of the membrane, while the major pressure as well as the weight of the fixed contact and its mounting structure is borne by the cover plate.

At the mobile contact end of the switch a similar annular membrane is arranged with metal-to-glass seal to the shell. In this case however, the inner rim of the annular membrane is integrally united with the outer rim of a metallic bellows which extends into the envelope and is hermetically closed across its inner end by an operator stem. The mobile contact of the switch is fixed on the inner end of the stem within the vacuumized envelope and in axial alignment with the fixed contact. The stem extends out of the open end of the bellows, and is connected to a solenoid or other operator.

Atmospheric pressure tends to close the mobile contact upon the aligned fixed contact to close the circuit through the switch. The solenoid or other operator when energized, pulls the mobile contact away from the fixed contact to open the circuit. The bellows permits both movements without break in the vacuum of the enclosing envelope.

A bearing tube in which the stem is slidably journaled is fixed within the open end of the bellows by a part of the cover plate at that end. Electrostatic shields or baffles surround the inner end of the stem and the bellows; and to facilitate construction and final assembly, the bellows-stem assembly is introduced into the envelope through the fixed end, in which is the last opening to be closed.

The arrangement of parts and the membranes is such that in the event a part within the envelope must be replaced or repaired, the membranes may be cut to give access, and then rejoined and the envelope again exhausted for further use.

In detail my switch comprises a cylindrical glass shell 2 around the inside edges of which at each end is integrally fused a glass apron or flare 3, extending inwardly to a bead 4. Shell and flare are preferably of Pyrex glass which, of various dielectric materials, has the desired transparency, mechanical and dielectric strength, and heat resistance.

Around the upper or fixed end an annular copper membrane 5, having a generally U-shaped or return bend section is arranged, the outer flange thinning down into the bead 4 in a conventional metal-to-glass seal; and the inner flange extending upwardly to the plane of the shell end. At this edge, it is integrally united by the weld 6 to the upturned edge of a second annular copper membrane 7, the inner edge 8 of which is flanged upwardly and integrally united to a cylindrical copper mounting block 9. Because of its flexibility, the annular structure surrounding the mounting block insures integrity at that end of the envelope.

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Overlying the end of the shell is a heavy end plate 12, to which the mounting block is tightly held by the cap screw 13. In order to provide better heat and current conduction, the end plate 12 mainly of steel, is preferably faced on its inner surface with copper 14 of material thickness, say $\frac{1}{8}$ ". A copper alignment ring 16 is brazed to the copper face 14 of the plate 12 to insure proper position on the shell. Mounting holes 17 are formed about the rim of the end plate; and a threaded hood 18 protects the pinched end of the metal tubulation 19, brazed in the mounting block 9 in continuation of the passage 21 and extending through the end plate as shown. Fixed in the copper mounting block is the copper contact mount 22 and in it is fixed the tungsten contact or electrode 23. These heavy copper parts thus provide ample conduction for heavy currents and escape for generated heat.

It will be observed that this structure provides a hermetically tight end for the shell entirely within it and immediately below the end cover plate. So constructed only a relatively small area including the metal-to-glass seal is subjected to unsupported atmospheric pressure. A major portion of such stress is carried by the end plate, which in addition, supports the weight of the mounting block, contact mount and fixed contact, and receives the shock and thrust of the closing and closed contacts.

At the other or lower end of the shell is the mobile contact or electrode 26 of tungsten mounted in the head 27 of the solid copper stem 28. The stem is slidably journaled in a bearing tube 29, fixed by cap screws 31 on the steel cover plate 32, which overlies the annular steel plate 33, and with it forms the end plate for the mobile end of the switch. Cap screws 34 secure the two together, and an alignment ring 35 welded to the plate 33 positions the end plates on the shell.

This end also is hermetically sealed by an annular copper membrane 36, making a metal-to-glass union with the flare 3, and extending upwardly to a welded union 37 with the upturned flange 38 of the annular membrane 39, the downturned flange 40 of which adjoins and is welded at 41 to the flange 42, which marks the outer or open end of the expansive means conveniently a bellows 43.

Both flanges 40 and 42 lie snugly between the inner edge of the annular plate 33 and the outer edge of the enlarged end of the bearing tube 29, the adjacent edges of plate and head being beveled as shown, to give access to the weld.

The inner end of the bellows is closed by and brazed to the solid stem, and thus continues the hermetic closure at this end of the shell. A copper shield or cup 44 fixed to the stem adjacent the head surrounds the bellows and protects it from bombardment by particles emanating from the contact points. A similar baffle or shield 45 provides similar protection for the cup and helps to disperse such particles toward the fixed end of the shell.

An actuator for the switch, such as a solenoid (not shown) is connected by a link 46 to the copper stem 28. The end of the link is threaded into a brass bushing 47 brazed into the free end of the stem. No means is provided for holding the end cover plates against the ends of the shell, since atmospheric pressure after vacuumization of the envelope is amply sufficient to fix them rigidly in place.

While the structure of my invention has been explained above without reference to sequence of assembly, such sequence is of great importance in realizing some of the objects of my invention. Essentially it is as follows:

The annular membrane 36 is first beaded, the flare attached, and then the flare is fused to the lower edge of the shell as shown. The membrane 38 is then put in place and the weld 37 made by heliarc process, working through the open top of the shell. The upper membrane 5, bead and flare are next assembled and the flare fused to the shell.

The entire fully brazed mobile contact assembly of

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contact, stem 28, bellows, baffle, shield, and bearing tube 29 may now be lowered through the aperture in the membrane 5 to place the bellows flange 42 within its mating flange 40 in position for the heliarc weld 41. The two end plates 32 and 33 are seated to complete this end of the switch.

To close the open upper end of the envelope, the brazed fixed contact assembly of membrane 7, mounting block 9, open tubulation 19, contact mount 22 and contact 23 are set within the membrane 5, and the heliarc weld 6 made. The end plates are then applied and the cap screw 13 tightened to connect the mounting block 9 rigidly to the plates. Vacuumization and sealing off the tubulation follows.

Because of the high cost of making a switch of the great size and capacity described, it is very desirable that they be so constructed that if need arise the envelope may be opened and inner parts be repaired or replaced. This is accomplished by removing the upper end plate 12—14 and opening the heliarc welded joint 6, whereupon the fixed contact assembly may be lifted out. If it is necessary to remove the mobile contact assembly, the lower plates 32—33 are also removed and the weld 40 cut so that the assembly can be lifted through the previously opened upper end. After repair and reclosing, the envelope is once more vacuumized.

I claim:

1. In a vacuumized electrical implement, a dielectric shell, an annular conductive membrane having its outer edge hermetically joined to one end of the shell, said annular membrane having a portion adjacent said shell extending inwardly of the shell and an inner edge forming an outwardly extending flange, a second annular membrane disposed wholly within said shell and having an outer edge forming an outwardly extending flange integrally united to the first named flange, means constituting a conductive mounting block closing the central opening in the second annular membrane and integrally united therewith, and a conductive rigid member detachably secured to said conductive block and overlying said membranes, said conductive rigid member having end portions in contact with said end of said shell.

2. In a vacuumized electrical implement, a dielectric shell, an annular conductive membrane having its outer edge hermetically joined to one end of the shell and its inner edge forming an outwardly extending flange, a second annular membrane having an outer edge forming an outwardly extending flange integrally united to the first named flange, means constituting a conductive mounting block closing the central opening in the second annular membrane and integrally united therewith, a conductive plate overlying the end of the shell and the membrane and rigidly fixed to the mounting block, an alignment ring for the shell fixed on the adjoining surface of the conductive plate, and a tubulation integrally united with the block and extending at one end through the conductive plate and outside the shell and at the other end opening on a face of the block inside the shell.

3. An electrical implement comprising a vacuumized envelope having a cylindrical non-conductive shell, a centrally apertured plate overlying one end of the shell, an annular membrane having an inner flange disposed within the plate aperture and an oppositely extending outer flange, means hermetically joining the outer flange to the adjacent end of the shell, a bellows in the envelope having at its outer end an annular flange contiguous with the membrane inner flange and integrally united therewith, a bearing tube external to the envelope and within the bellows, means for rigidly mounting the bearing tube on the apertured plate, a conductive stem slidably journaled in the bearing tube and integrally united with the bellows' end, a mobile electrode mounted on the stem within the vacuumized envelope, an end plate hermetically closing the other end of the shell, and a fixed elec-

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trode operatively aligned with the mobile electrode and mounted on the end plate.

4. An electrical implement comprising a vacuumized envelope having a cylindrical non-conductive shell, a centrally apertured plate overlying one end of the shell, an annular membrane having its outer portion hermetically joined to the adjacent end of the shell, a bellows in the envelope hermetically joined at its outer end to the inner portion of the membrane, a bearing tube external to the envelope and within the bellows, means for rigidly mounting the bearing tube on the apertured plate, a conductive stem slidably journaled in the bearing tube and integrally united with the bellows' end, a mobile electrode mounted on the stem within the vacuumized envelope, an end plate hermetically closing the other end of the shell, and a fixed electrode operatively aligned with the mobile electrode and mounted on the end plate.

5. An electrical implement comprising a vacuumized envelope having a cylindrical non-conductive shell, a centrally apertured plate overlying one end of the shell, an annular membrane having its outer portion hermetically joined to the adjacent end of the shell, a bellows assembly in the envelope hermetically joined at its outer end to the inner portion of the membrane, a bearing tube external to the envelope and within the bellows, means for rigidly mounting the bearing tube on the apertured plate, a conductive stem slidably journaled in the bearing tube and integrally united with the bellows' end, a mobile electrode mounted on the stem within the vacuumized envelope, an annular membrane having its outer portion hermetically joined to the other end of the shell and having a central opening large enough to pass the bellows assembly, means for hermetically closing the central opening, and means for mounting a fixed electrode on the closing means in alignment with the mobile electrode.

6. In a vacuum switch, a vacuumized envelope comprising a non-conductive cylindrical shell, a pressure bearing plate disposed across each end of the shell, an an-

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nular membrane at each end of the shell and hermetically joined thereto inside the plate, a central membrane adjoining the pressure plate at one end of the shell and integrally united to the adjacent annular membrane around its inner rim, a bellows closed at its inner end and open at its outer end arranged in the other end of the shell and integrally united at its outer rim with the inner rim of the adjacent annular membrane, a slide bearing fixed on the pressure plate adjacent the bellows, a stem in the bearing and extending into the bellows and integrally united to the closed end thereof, a mounting block integral with the stem and within the envelope, a second mounting block integral with the central membrane, and aligned electrodes mounted in the blocks.

7. A vacuum switch as recited in claim 6 in which electrostatic shields are mounted on the stem adjacent the closed end of the bellows, one of the shields facing toward the electrodes and the other surrounding the bellows.

8. A vacuum switch as recited in claim 6 in which the pressure bearing plate at one end of the shell is releasably secured to expose the seam between the central and annular membranes.

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