A mercury button for a mercury switch is provided with improved closure of the steel shell thereof. Prior thermal stresses are reduced and practically eliminated to reduce fracture of a glass insulator portion of the steel shell closure by generating welding heat uniformly about the metal ring enclosing the annular glass insulator.
MERCURY BUTTON CLOSURE

Mercury buttons and mercury switches are known in the art. Mercury buttons have been made for many years and switches enclosing these buttons and providing means for turning the button about a cylindrical axis thereof have also been provided in numerous forms and structures.

The turning of a button on its cylindrical axis when this axis is horizontal causes a ceramic liner within the steel shell to separate a pool of mercury into two pools when the switch is turned "off" and permits the two pools to recombine into a single pool when the switch is turned "on."

The ceramic liner serves to separate the mercury and allow it to recombine as it is an insulating material. Flow of current passing through the mercury reaches the button exterior through the metal shell. Obviously some insulator is needed to separate a portion of the shell conducting electricity from one pool from another portion conducting electric power from the other pool.

In prior art mercury buttons, two similar shaped metal shells were held in insulating relation on either side of the button by a glass bead which was bonded both to the two shells and to the insulating ceramic liner in the button. One mercury pool contacted each half metal shell.

One problem with this structure is that as attempts were made to use buttons of such structure for switching of higher levels of power, higher levels of pressure were generated in button as higher levels of pressure as mercury was vaporized during the make or break of the mercury pools. The glass did not have good mechanical properties in tension and rupture of the button would occur as higher power values were switched.

A new form of button was developed as described in U.S. Pats. Nos. 3,229,354; 3,327,084; and 3,415,965. The closure for the button of these patents is a central metal contact separated from an outer metal rim by an annular glass insulator.

This button is capable of withstanding higher internal pressures than prior art buttons partly because the glass closure is not in tension as a result of generation of higher internal pressure.

However, with the switching of higher power and the containment of higher pressures within the shell there is an increased tendency toward loss of hermetic seal at the glass ring and to weakening or rupture of the glass as the higher pressures are generated. These pressures may be the result of mercury vapor generation or of heating of other gases included in the button in various admixtures as described in prior art patents to achieve various performance characteristics.

The problem of closure exists internally of the button also because, as is evident from U.S. Pat. No. 3,415,965 and earlier patents, when the button is in the off position one of the mercury pools is held within a chamber defined by the ceramic liner in combination with the annular glass insulator and the central metal contact extending through the annular glass insulator.

Where any separation or gap occurs between the glass insulator and the ceramic liner, current can leak through the gap and flow when the button is supposed to be in the off position. Actually in the buttons of the art the ceramic is bonded to the glass at the time the bond is formed between the glass and steel parts of the product. A strain of the joint between the ceramic and the liner, or a strain of either the internal or external joint between the glass and the metal of the closure can be detrimental to operation of the button under circumstances in which higher power is being controlled and greater internal pressures or arcing are being generated.

The method of manufacture of the three element assembly of glass, ceramic and metal is taught in U.S. Pat. No. 3,327,084. This entire assembly is welded as a closure element to the metal shell and the form of this shell is seen in the figures of the patents referred to above.

However, it was found that numerous buttons were not hermetically sealed and further that strains were developed in the three element glass-metal-ceramic assembly and that these strains led to failure of the buttons particularly at the higher levels of power switching.

It is accordingly one object of the present invention to provide a mercury button which may be manufactured more effectively in volume production.

Another object is to provide a mercury button which in volume production has reduced susceptibility to thermal and physical shock.

Still another object is to provide a mercury button which in volume production is capable of withstandin higher internal pressures.

A further object is to provide a welded button having reduced strain in a compression glass seal thereof.

Other objects and advantages will be in part obvious and in part apparent in the description which follows.

In general the objects of the invention may be achieved by providing a mercury button switch having a ceramic liner adapted to separate contained mercury into two pools by rotation of said button about a cylindrical axis thereof which comprises,

a cup shaped metal container having a closed end and an open end, a flat outwardly extending flange at the open end of said cup,

closure for said open end including a steel outer ring, an inner steel contact and an annular glass insulating ring bonded between said outer ring and inner contact, said closure having said ceramic liner bonded to the glass of said closure,

a weld between the outer portion of said ring and a mid-portion of said flat flange,
said weld being of uniform width around the perimeter of said cup to impart minimum stress to the glass of said closure during heating of said button from internal arcing therein.

The manner in which the objects may be best accomplished is explained best with reference to the accompanying drawings in which:

FIG. 1 is a sectional view of a prior art mercury button taken along the rotational axis of the button.

FIG. 2 is a perspective side elevation of an assembled button of a type produced heretofore.

FIG. 3 is a detailed sectional view of a rewelding assembly of a prior art button.

FIG. 4 is a detailed sectional view of a rewelding assembly as in FIG. 3 but showing components as used pursuant to this invention.

FIG. 5 is a view similar to that of FIG. 4 but showing the post-welding assembly.
FIG. 6 is a side elevation of a mercury button having a weldment as shown in FIG. 5. Referring first to FIG. 1 a sectional view of a mercury button is seen in the form of prior art patents referred to above. Briefly the structure includes a steel shell 12 having a general cup form and having an outwardly extending flange 12 and upwardly extending lip perimiter 14.

Within the cup is positioned the ceramic liner 16 having upper chamber 18 and lower chamber 20 and connecting through hole 22 and axially disposed vent hole 24. The ceramic liner is bonded to an annular glass insulator 26 at an annular bead 28. Centrally disposed in insulator 26 is center contact 30 having externally extending shank 32 and internally disposed nail head contact 24.

Outer rim 36 is welded to shelf 12 and lip 14 in closing the button to contain a quantity of mercury and whatever special atmosphere is employed. This prior art closure has produced problems both at the time of fabrication and for those which have evidently been formed successfully, during testing or field use following completion.

The improvements of the new structure are distinguished from prior art devices by a more detailed description first of the prior art closure as shown in FIG. 3. Referring now to FIG. 3 it is evident that the outer rim 36 has a downwardly depending lip 38. This lip is of the sort formed by the downward pull of a forming tool as the ring is punched from a metal sheet. A certain amount of the feathered out metal edge at 38 can be removed as by tumbling metal parts. It is, of course, evident that a part of a structure such as the metal ring 36 can be formed by machining and close tolerances can be achieved to at least partially offset the irregularity of the edge of ring 36 as illustrated in FIG. 3. A machined edge can be achieved in the form illustrated at corner 37 for example. However, at the same time it must be realized that such machining and precise dimensioning of parts adds appreciably to the cost and one of the objectives of producing a mercury button switching structure is that it be produced at low cost although still performing the function of the product in a very satisfactory if not superior fashion.

What is somewhat unique about the structure of the present invention is that it performs its function in a fashion which is superior to the fashion in which a structure formed of machined parts according to the scheme illustrated in FIG. 3 would operate.

Returning now to FIG. 3 the edge 38 is seen to have the characteristic form (though somewhat emphasized for purposes of illustration) of a depending triangular edge of metal.

Such an edge would be produced normally at both 37 and 38 but 37 is illustrated as if machined for comparative purposes as its edge configuration is not as critical in the formation of a good glass-metal-ceramic bond as is the configuration of edge 38 in formation of a satisfactory or superior weldment.

The surface which receives the edge 38 is the internal corner formed at the intersection of the outwardly extending shelf 12 and upwardly and outwardly extending lip 14.

What has been found deficient in this prior art closure is the uneven generation of welding heat around the perimeter of the metal ring and accordingly of the glass insulator. In other words because of the unevenness of the depth and dimensions of downwardly protruding edge 38 itself, and because of the unevenness of the contact of edge 38 about the perimeter of the rim 36, it was found that higher heating temperatures were produced at some portions of the rim as compared with others and consequently an uneven heating of the glass insulator ring 26 occurred during welding. While this uneven heating, if it occurred over a period of time, might lead to thermal gradients of acceptable intensity, when the heating takes place as a result of welding, it is very intense. The temperature gradients produced during welding are more in the nature of thermal shocks such as produce strain and stress in the glass-metal and glass-ceramic joints as well as in the glass itself and in the ceramic bead 28 itself.

The thermal shocks are increased in use of rim such as illustrated in FIG. 3 both because of variability of taper of the downwardly depending triangular bead 38 and also because of the centering effect of the lip 14. In other words the bead 38 may at portions of the rim contact lip 14 and at other portions contact shelf 12. It has been discovered that the difference in weld heating at various location around the rim produces thermal stresses in the glass insulator ring and leads either to malformation of the closure seal or to a latent weakness which can be adversely affected by the high pressures generated in the button chamber during the switching operations involving control of higher levels of power.

In part the uneven heating is caused by variations in the depth and edge contour of edge 38 and in part by the placement of the edge 38 against the inner surface of lip 14.

It is evident from the foregoing description in relation to the figures that some dimensional variation occurs in the weldments formed in the prior art devices. It had not previously been found feasible to eliminate such dimensional variation of the welded structures except at substantially unacceptable high costs. It is the dimensional variability which leads to the placement of the depending edge such as 38 against the sloped surface of lip 14 for example. It is, of course, the attainment of the high performance capabilities at low cost which is the desired combination of features provided by applicant.

By contrast and pursuant to this invention a downwardly extending plateau 138 is provided on rim 139 as illustrated in FIG. 4, rather than a depending edge such as 38 extending from a flat rim such as 39 of FIG. 3. The plateau may be formed by punching where the upper surface of rim 139 forms the lower surface of the punched part, and the shelf 12 is extended to a flange 112. Because the flange 112 extends outwardly only and has no lip component, the flat 140 of the depending plateau meets only the upper matching flat surface of flange 112. The plateau 138 and flange 112 are contacted prior to welding and a standard is established in their manufacture so that the mating surfaces are formed with a slight flat so that an effective Lapping of the flat confronting surfaces occurs. The welding electrodes are applied to the underside of flange 112 and to the top surface 139 or rim 138 and a pressure is exerted between them prior to welding. Because flange 112 is flat as shown in FIG. 4 in contrast to flange 12 and connecting lip 14 of FIG. 3 the appli-
cation of pressure can straighten out any minor depression in the flange prior to start of the actual welding.

Lip 14 on flange 12 serves as a reinforcing element against such straightening out of irregularities of flange 12.

Also, the width of the flat 140 of the Depending plateau is established so that the welding current will generate the appropriate welding temperatures uniformly around the rim 139. It is this uniform temperature generation all around the rim and weld area that has been found to substantially reduce or eliminate the thermal shock and thermal stress which led to so many faulty mercury buttons.

The actual shape of the rim is somewhat exaggerated for purposes of illustration and the flat 140 of the plateau 138 may be of the order of a few thousandths of an inch. The plateau itself may have a base several times the width of flat 140 and the width of rim 139 may conveniently be several times the width of the base or of the order of one tenth or an eighth of an inch.

The definite plateau surface can be formed by punching from above as in the case of the rim 36 of FIG. 3, but with a die supporting the underside of rim 139 which die has a contoured face corresponding with a stepped outer edge so that plateau 138 and flat 140 are affirmatively formed as the part is punched. Any burr on plateau 140 is removed by tumbling of parts prior to use and no burr is shown on plateau 138.

The device prior to welding closure is shown in FIG. 4 and the mated surfaces following welding is illustrated in FIG. 5.

Because of the improved shape of rim 139 and flange 112 less heat is produced during the weld although an improved weld is formed. Only about 85 percent of the heat formed in welding the structure of FIG. 3 is produced in welding the structure of FIG. 4.

Moreover as explained above the heating is much more uniformly spread around the perimeter of the button.

Another source of heating of the glass insulator is the heating which accompanies internal arcing when the pools are separated. Depending on the voltage applied and current passing through the switch when the pools are separated there is a tendency for an arc to persist between the separated pools. Where the arc strikes the steel shell rapid local heating occurs. As the heat spreads out it reaches the rim area of the button unevenly. Because of the improved structure at the rim and the limited stress of the glass and ceramic elements and joints generated during formation of the assembly, the improved button is able to withstand a higher level of such arcing than can be withstood by button structures which do not have the uniform weld construction of this invention.

What is claimed is:

1. A mercury button switch having a ceramic liner adapted to separate contained mercury into two pools in two use orientations inverted relative to one another by rotation of said button about a cylindrical axis thereof which comprises,

   a cup shaped metal container having a closed end and an open end, and a flat outwardly extending flange at the open end of said cup,

   a closure for said open end including a steel outer ring, an inner steel contact and an annular glass insulating ring bonded between the outer ring and the inner contact, said closure having said ceramic liner bonded to the glass of said closure,

   a weld between the outer portion of said ring and a mid-portion of said flat flange,

   said weld being of uniform width around the perimeter of said cup to impart minimum stress to the glass of said closure during heating of said button from internal arcing therein.

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