A method of fabricating a three-terminal voltage surge arrestor comprising the steps of forming an electrically conductive hollow housing having a cylindrical side wall extending between opposed open ends of the housing, the side wall including a longitudinally extending welding flange at each end; disposing a pair of electrically insulative hollow cylindrical members for disposition within the housing adjacent opposing ends thereof; disposing a pair of electrode rods through the ends of said housing, including a means thereon for engaging its associated welding flange as the rod is inserted into the housing through an end thereof to concentricize the rod in the housing; securing one electrode rod to an end of the housing by welding to said welding flange; withdrawing air from the interior of the housing through the other end of the housing; injecting a noble gas into the interior of the housing through said other end of the housing; securing the other electrode rod to said other end of the housing by welding; and isolating a segment of the housing side wall from both electrode rods.

4 Claims, 8 Drawing Figures
METHOD OF FABRICATING A THREE-TERMINAL VOLTAGE SURGE ARRESTER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to voltage surge arrestors and, more particularly, to a method for fabricating a three-terminal voltage surge arrester.

2. Description or the Prior Art

Three-terminal surge arresters are well known in the art as exemplified by U.S. Pat. No. 3,333,153 issued on July 25, 1967 to Wanaselja.

A three-terminal voltage surge arrester is an ionization chamber formed in an electrically conductive housing wherein a pair of opposed electrodes are inserted into the chamber with a gap defined between the opposing ends of the electrodes and another gap defined between the end of each electrode and the housing side wall. The two electrodes constitute the two active terminals of the surge arrester which are connected across an electrical instrument to be protected, whereas the third terminal of the arrester is defined by the housing side wall which is grounded.

In manufacturing three-terminal voltage surge arresters, it is important that the pair of electrodes is positioned concentrically within the ionization chamber and in axial alignment with one another. Also, it is important to maintain a desired interelectrode gap between the opposing inner ends of the electrodes. In a true "three-terminal" voltage surge arrester, such interelectrode gap should equal the gap between each electrode and the housing side wall. It will be realized that the dimensions of these gaps necessarily determine the breakdown characteristics of the voltage surge arrester; i.e., the maximum voltage potential across the electrodes prior to ionization of the gas. In addition a convenient method of withdrawing air from the ionization chamber and substituting a readily ionizable gas will substantially facilitate the manufacture of the device.

SUMMARY OF THE INVENTION

The method of this invention comprises the steps of forming an electrically conductive hollow housing having a cylindrical side wall extending between opposed open ends thereof, the side wall including a longitudinally extending welding flange at each end; placing a pair of electrically insulating hollow cylindrical members within the housing adjacent opposing ends thereof and in spaced apart relation to one another to leave interiortly exposed a central part of said conductive housing; placing a pair of rod like electrodes into said ends of said housing, each electrode including means thereon for engaging its adjacent welding flange as the electrode is inserted into the housing to concentricize the rod in the housing; the confronting ends of said electrodes being spaced from one another a distance substantially equal to the distance said ends are from said exposed central part of said housing; welding one electrode rod to an end of the housing to seal it thereto; withdrawing air from the interior of the housing through the other end of the housing; injecting a noble gas into the interior of the housing through said other end of the housing; welding the other electrode rod to said other end of the housing to seal it thereto; and isolating a segment of the housing side wall from both electrode rods.

In a preferred embodiment of this invention, the concentricizing means on each electrode rod comprises a stop having a base portion of greater outer diameter that the inner diameter of the housing, and an inwardly tapered shoulder. If any part of the welding flange on an end of the housing engages the shoulder as the electrode rod is inserted into the housing through such end, further inward movement of the rod will cause the rod to shift laterally into concentricity with the housing, which concentricity is obtained when the base portion engages the welding flange. At this point, the rod is restrained from further inward or lateral movement thereby being maintained in concentricity with the housing.

These and other aspects and advantages of the present invention will be more clearly described with reference to the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a longitudinal cross-sectional view of a housing formed in accordance with the method of this invention;

FIG. 2 is a longitudinal cross-sectional view of an insulative member formed in accordance with the method of this invention;

FIG. 3 is a side elevation view of a solder ring adapted to be snapped into an annular groove in the hollow member of FIG. 2;

FIG. 4 is a side elevational view of an electrode formed in accordance with the method of this invention;

FIG. 5 is a fragmentary cross-sectional view, partly in elevation, of a voltage surge arrester of this invention shown in one stage of assembly;

FIG. 6 is a cross-sectional view, partly in elevation, of the arrester of FIG. 5 shown in another stage of assembly;

FIG. 6A is a fragmentary view, similar to FIG. 6 but in enlarged scale, showing one end of said arrester; and

FIG. 7 is a cross-sectional view, partly in elevation, of the voltage surge arrester of FIG. 6 shown in completed form.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The device to be manufactured by the present method is shown in FIG. 7, wherein it is generally designated by the reference numeral 50. The device or surge arrester 50 comprises a pair of insulative tubes 22 which are in axially aligned and spaced apart relation. Bridging the space between the tubes 22 is a conductive metal segment 42 which is in telescoping relation with each tube 22 and its connected in hermetically sealed relation with the telescoping portions of the tube 22 by means of solder rings 30. The insulative tubes 22 and the conductive central portion 42 define an outer housing which is capped at each end by an electrode assembly including an elongated electrode element 32 having a cap at its outer end, the cap being formed of flanges 36 and inwardly extending tubular metallic portions 52 welded to said flanges, the metallic portions 52 being joined in hermetically sealed relation to the tubes 22 by solder rings 30. The free ends 38 of the electrodes 32 are spaced apart a distance or space defined by the gap 40 that is equal to the radial gaps 41 be-
between said electrodes and the concentric center portion 42.

The interior space defined by the above described structure is filled with a readily ionizable gas such as a noble gas. As is well known, whenever there is a voltage surge on either electrode (and hence on the line to which it is connected) which is sufficient to cause conduction across the gap 41 from one electrode 32 to ground as represented by the metal segment 42 the gas will become ionized and will accordingly establish conductive paths between the two electrodes 32 and between both electrodes and ground whereby to protect equipment from the voltage surge.

The method of forming the three-terminal voltage surge arrester 50 above described will now be set forth in detail. Referring now to FIG. 1 of the drawing, a first step of the method of this invention comprises forming an electrically conductive hollow housing 10 having a cylindrical side wall 12 extending between opposed open ends 14 and 16 of the housing. Housing 10 is preferably metallic and most preferably made of a brazable, weldable metal such as nickel-iron alloy, brass or cooper. Side wall 12 is preferably circularly cylindrical and preferably includes an annular boss 18 formed on the inner surface 19 of the side wall boss 18 lying substantially intermediate ends 14 and 16. Boss 18 is defined by a pair of shoulders 19a and 19b.

Housing 10 is formed with an outwardly longitudinally extending welding flange 20 at each end thereof. Preferably, each welding flange is annular and is tapered to a knife edge 23 (see FIG. 5). Alternatively, and if desired, each welding flange 20 may be defined by a plurality of spaced welding protruberances (not shown) extending outwardly from each end of the housing and each terminating in a knife edge.

Referring now to FIG. 2, the next step of the method of this invention includes forming a pair of hollow insulating members 22 (only one being shown in FIG. 2), wherein each hollow member includes a cylindrical side wall 24 extending between a pair of opposed open ends 26. Each hollow member 22 is fabricated of a high temperature resistant electrically insulating material such as glass or ceramic. Alumina is the preferred material for members 22. Each hollow member 22 is formed with an outer diameter substantially equal to the inner diameter of side wall 12 of housing 10, and a length slightly less than the distance between each end of housing 10 and the closest shoulder 19a or 19b of annular boss 18 to such end within the housing. In this manner, each hollow member 22 may be fitted in the housing with one end 26 of said member in contact with a shoulder 19a or 19b and the other end of said member lying near one end of the housing. This relationship is more completely described below.

Preferably, although not essential to the method of this invention, each hollow member 22 is formed with at least one circumferential groove 28 in side wall 24. Most preferably, each hollow member 22 is formed with a pair of circumferential grooves 28, each located adjacent a separate end of the hollow member. Preferably, each groove is of approximately hemispherical cross section. Each groove 28 is designed to receive a solder ring 30 (FIG. 3), preferably having a circular cross section of a diameter slightly less than the cross sectional radius of grooves 26. Solder ring 30 is designed with a gap 30a so that it may be expanded and then snapped into a particular groove 28.

Referring now to FIG. 4, and in accordance with the next step of the method of this invention, a pair of electrode rods 32 are formed to serve as the two line connected electrodes of the arrester. Thus, rods 32 are fabricated of an electrically conductive material such as metal, preferably copper. Preferably, each rod is comprised of a solid cylindrical shaft 33 extending between opposing ends 38 and 39 thereof, and including a stop or flange 34 formed thereon. As shall be described in more detail below, stop 34 cooperates with a welding flange 20 on housing 10 to guide the rod into concentricity with the housing.

Preferably, stop 34 comprises a circular base portion 36 and an inwardly tapered or frusto-conical shoulder 37. More specifically, shoulder 37 is tapered from a maximum diameter at base portion 36 which is less than the diameter of base portion 36, to thereby define an annular rim 39 at the outer periphery of the shoulder. Shoulder 37 tapers to a minimum diameter adjacent shaft 33 which is greater than the diameter of shaft 33. It is important that the line of intersection of shoulder 37 with base portion 36 be equal in diameter to the inner diameter of each welding flange 20 at outer edge 23 thereof.

With such arrangement, it will be noted that when end 38 of electrode shaft 33 is inserted into housing 10, such as through end 16 thereof, and in the event the electrode shaft is initially eccentric with the housing, a portion of welding flange 20 at housing end 16 will engage frusto-conical shoulder 37 to thereby direct the shaft laterally into concentric alignment with the flange edge 23 and thus with the housing, which concentricity is established when edge 23 of the welding flange engages base portion 36 of stop 34. Further, with edge 23 of the welding flange at the line intersection between base portion 36 and shoulder 37, the electrode rod will be restrained from further movement laterally of its axis thereby being maintained in concentric alignment with the housing.

Continuing with the description of the method of this invention, after housing 10, hollow members 22, and electrodes 32 have been formed, solder rings 30 are snapped into associated grooves 26 in hollow members 22. Then, each hollow member is inserted into housing 10 through a distinct end thereof in the manner above described. This is followed by inserting one electrode rod 32 through the associated hollow member 22 into the interior of housing 10, the inward progression of said electrode being guided into concentricity with the housing by the cooperation of welding flange 20 with stop 34 in the manner above described.

Referring now to FIGS. 6 and 6A, the next step of the method of this invention comprises securing the one electrode to an associated end of the housing. This is preferably accomplished by heating such end of the housing to weld the electrode thereto. In such welding process, the rod is preferably moved further into housing 10 by applying an inward force thereto so that the welding flange will melt down and effect a hermetic seal between the flange 36 and the housing 10. This is preferably accomplished by resistance welding, although other well known welding techniques may be employed.

The solder ring 30 closest the end of the electrode which has been welded to the housing is softened to seal the housing to the adjacent hollow member 22. It will be realized that if the application of external heat
is used to weld the electrode to housing 10, the solder ring 30 in the hollow member 22 adjacent the flange 36 will be caused to melt thereby simultaneously effecting a hermetic seal between the housing side wall and such hollow member.

After one electrode 32 has been welded to end 16 of housing 10, the other electrode 32 is disposed concentrically within the housing and all of the air in the interior of the housing is evacuated therefrom by a conventional vacuum assembly (not shown). (It will be recognized that the second electrode could have been so positioned earlier in the process and then held in its concentric position by suitable means.) At some point in the process up to this point, preferably at this point, the two inner solder rings 30 are softened to form second hermetic seals between hollow members 22 and metal wall 10. The purpose of this will become apparent hereinafter. The housing is then preferably transferred to a conventional “dry box” which typically contains dry nitrogen. At this point, a noble gas, such as argon, is injected into the dry box to drive out the nitrogen whereupon the noble gas passes into the interior of housing 10 through non-welded end 14 thereof. Then, the nonwelded electrode 32 is secured to end 14, preferably in accordance with the procedure above outlined for welding the first electrode to end 16 of housing 10. The assembled structure is shown in FIG. 6 wherein the pair of electrodes represent the two active terminals of a three-terminal voltage surge arrestor.

So structured, it will be noted that an interelectrode gap 40 is formed between the inner ends 38 of the pair of electrode rods, and that the gap 41 is formed between the electrode rods and boss 18 of housing side wall 12. Preferably, the extent of gap 40 in a direction parallel to axis 21 of the housing substantially equals the extent of gap 41 in a direction perpendicular to said axis. It has been found that such relationship between gap 40 and gap 41 optimizes the efficiency of the arrestor and, in fact, is a requirement of a true three-terminal voltage surge arrestor.

Referring now to FIG. 7, the next step in the method of this invention will be described. More specifically, it is desired that the side wall 12 of housing 10 contain a segment 42 thereof to be grounded and used as the third and ground terminal of the surge arrestor. To this end, it is important that at least a portion of such a segment include boss 18 so that when the gas is ionized, the current flow will be from the electrodes through gap 41 to ground.

In forming segment 42 of housing side wall 12, it is essential to isolate the segment from the pair of electrode rods 32. One way of accomplishing this is to remove a complete circumferential portion of housing side wall 12 near each end of the housing leaving segment 42 (FIG. 7) between the spaces formed in the housing side wall with said portions removed. Preferably, each such portion is removed from the housing side wall in an area between the pair of solder rings in each hollow member 22. For example, see spaces 44 and 46 formed in housing side wall 12 thereby defining segment 42 therebetween (FIG. 7). A preferred way of removing the pair of housing portions to form spaces 44 and 46 is by placing housing 10 on a lathe or the like and cutting or annulling rings between each of the two pairs of solder rings 30 in the hollow members. Then, segment 42 is isolated from electrodes 32 and may serve as the third or ground electrode.

In accordance with the method as above outlined, a three-terminal voltage surge arrestor 50 is formed, as shown in FIG. 7. The operating characteristics of surge arrestor 50 will be defined by the nature and characteristics of the specific gas and electrically conductive materials used, as well as by the dimensions of gaps 40 and 41.

Although the above invention has been described with reference to a specifically disclosed embodiment, the invention is not to be so limited. Rather, the invention is deemed to include obvious modifications and alternations to the specific embodiment above described.

Other obvious modifications and alternations within the skill of the artworker are contemplated in this invention. The precise scope of this invention is to be defined in the following claims.

What is claimed is:

1. A method for fabricating a three-terminal voltage surge arrestor comprising the steps of:
   a. forming an electrically conductive hollow housing having a cylindrical side wall extending between opposed open ends of the housing, the side wall including a welding flange at each end of the housing extending outwardly in a direction substantially parallel to the longitudinal axis of the housing;
   b. forming a pair of electrically insulative hollow cylindrical members for receipt within the housing adjacent opposing ends thereof;
   c. forming a pair of electrode rods each including means thereon for engaging the welding flange at an end of the housing as the rod is inserted into the housing through such end thereof to concentricize the rod in the housing;
   d. positioning the pair of hollow members in the housing adjacent opposing ends said housing and securing said hollow members in sealed relation to said housing;
   e. inserting the electrode rods into the housing through said hollow members until said means on each rod engages an associated welding flange on the housing side wall to concentricize the rod in the housing;
   f. securing in sealed relation therewith one electrode rod to an end of the housing;
   g. withdrawing air from the interior of the housing through the other end of the housing;
   h. injecting a readily ionizable gas into the interior of the housing through said other end of the housing;
   i. securing the other electrode rod to the other end of the housing; and
   j. electrically isolating a central segment of the housing side wall from both electrode rods.

2. The method of claim 1, wherein the means for engaging the welding flange to concentricize said rods comprises a base on each said rod extending radially outward therefrom and a frusto-conical shoulder axially aligned with said rod and base and having a maximum radius adjacent said base and slightly smaller than the diameter of said welding flange, whereby axial movement of said electrode rods inward of said housing will laterally shift said rods when they are originally eccentric of said housing in a direction to concentricize said rods.

3. The method of claim 2, wherein the step of forming the pair of hollow members includes forming a pair of spaced apart circumferential grooves in the side wall of each hollow member, and wherein the hollow mem-
bers are secured in sealed relation to said housing by:
a. forming a piece of solder for each groove of a size and shape enabling such piece to be positioned within the groove along substantially the entire circumferential extent of said groove; and
b. positioning each solder piece in a groove in the side wall of a particular hollow member, which solder piece will melt upon the application of heat to effect a pair of spaced apart hermetic seals between said particular hollow member and the housing.

4. The method of claim 3, wherein the isolating step includes removing a complete circumferential portion of the housing side wall between each pair of hermetic seals.