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Jonassen

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[54] **METHOD OF FABRICATING A THREE-TERMINAL VOLTAGE SURGE ARRESTER**

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[52] **U.S. Cl.** **316/20,** 29/25.16, 317/62

[51] **Int. Cl.** **H01j 9/38**

[58] **Field of Search** .. 29/25.13, 25.16; 317/9 R, 62; 316/17, 18, 19, 20

[56] **References Cited**

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3,710,191 1/1973 Peche 17/62

Primary Examiner—Roy Lake
Assistant Examiner—J. W. Davie
Attorney, Agent, or Firm—Hubbell, Cohen & Stiefel

[57] **ABSTRACT**

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

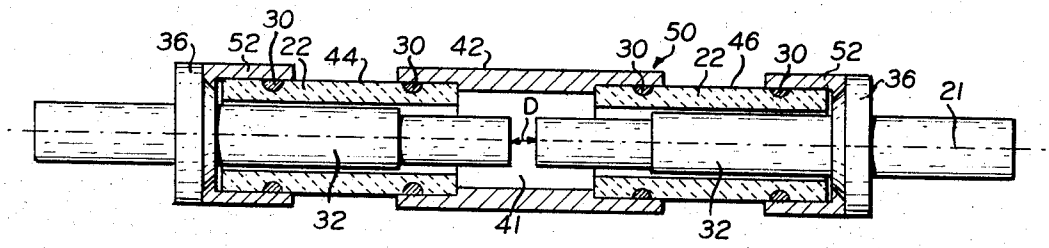


FIG. 1.

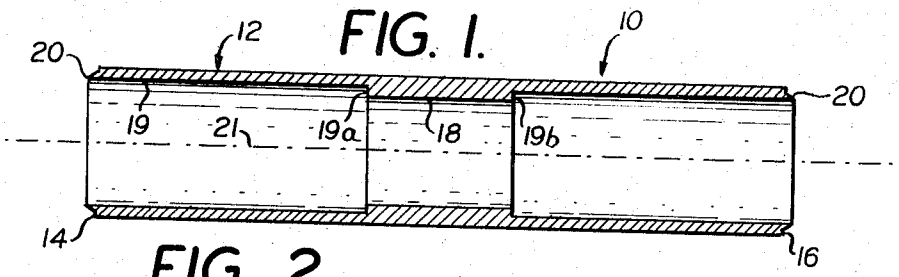


FIG. 2.

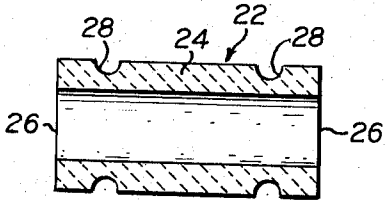


FIG. 3.

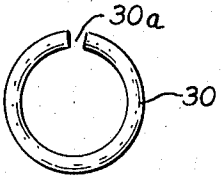


FIG. 4.

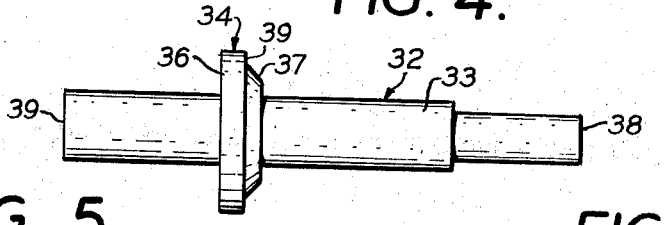


FIG. 5.

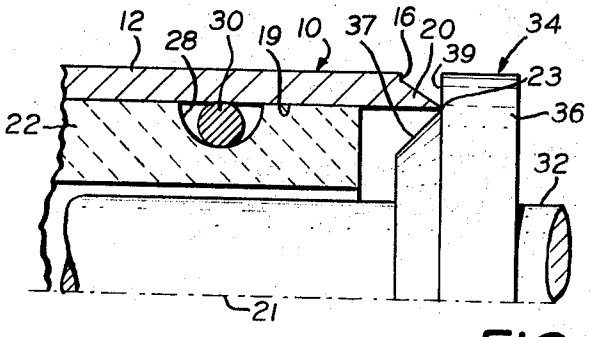


FIG. 6A.

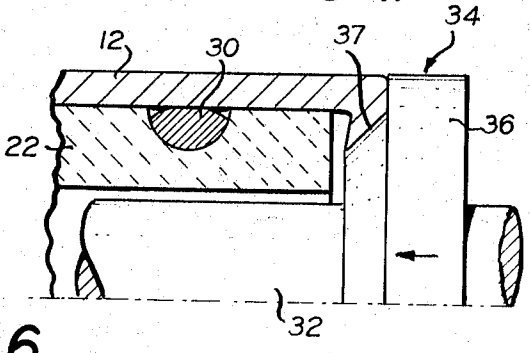


FIG. 6.

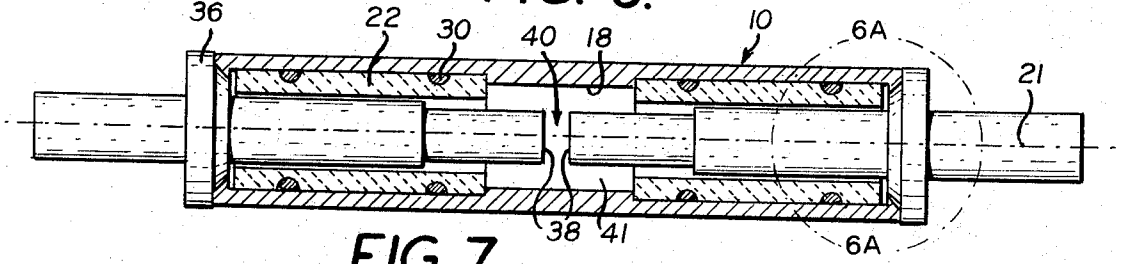
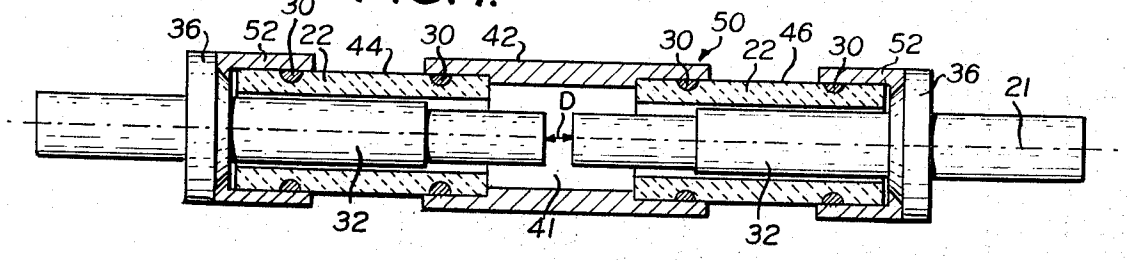


FIG. 7.



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 arrestor.

2. Description or the Prior Art

Three-terminal surge arrestors 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 arrestor 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 arrestor which are connected across an electrical instrument to be protected, whereas the third terminal of the arrestor is defined by the housing side wall which is grounded.

In manufacturing three-terminal voltage surge arrestors, 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 arrestor, 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 break down characteristics of the voltage surge arrestor, 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 insulative hollow cylindrical members within the housing adjacent opposing ends thereof and in spaced apart relation to one another to leave interiorally 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 arrestor of this invention shown in one stage of assembly;

FIG. 6 is a cross-sectional view, partly in elevation, of the arrestor 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 arrestor; and

FIG. 7 is a cross-sectional view, partly in elevation, of the voltage surge arrestor 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 arrestor **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-

tween 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 arrestor **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 **19***a* and **19***b*.

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 protuberances (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 **19***a* or **19***b* 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 **19***a* or **19***b* 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 **30***a* 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 arrestor. 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 non-welded 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 carving out annular 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.

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