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Attia et al.

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[54] VACUUM CIRCUIT INTERRUPTER

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[52] **U.S. Cl.** ..... **200/144 B**

[51] **Int. Cl.** **H01h 33/66**

[58] **Field of Search** ..... 200/144 B

[56] **References Cited**

UNITED STATES PATENTS

2,794,087	5/1957	Jennings et al.	200/144 B X
2,920,168	1/1960	Jennings	200/144 B
3,082,307	3/1963	Greenwood et al.	200/144 B
3,087,034	4/1963	Beers et al.	200/144 B
3,231,704	1/1966	Jacobs	200/144 B

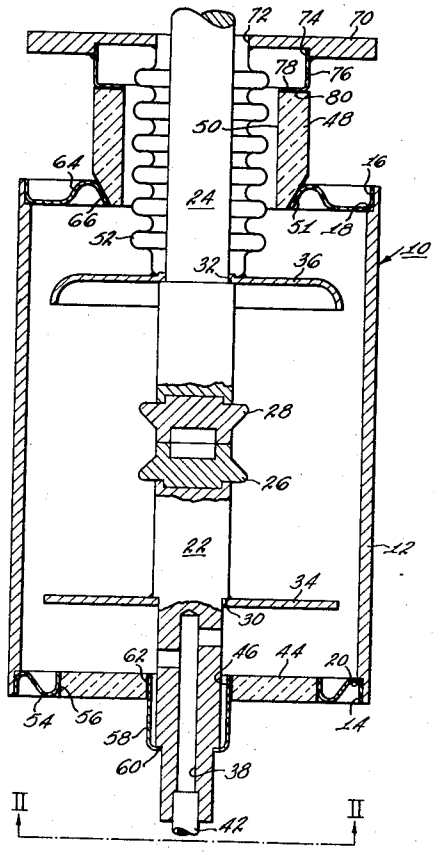
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[57] **ABSTRACT**

An improved vacuum type circuit interrupter rated at 50 mva and for use at a voltage level of 4.8 KV and above comprises a constant diameter hollow cylindrical copper envelope into which a stationary and movable OFHC copper contact rods extend. Each contact rod is provided at its tip with a copper-bismuth alloy contact. A pump-out port is provided through the stationary contact rod. In one embodiment, one end of the envelope is provided with a substantially flat ceramic end plate which has a central opening for accommodating the stationary contact rod. A thin Kovar sealing ring is disposed between the envelope and the outer periphery of the ceramic end plate and a thin Kovar sleeve is disposed between the end plate and the stationary contacr rod. The other end of the envelope is provided with a hollow cylindrically shaped ceramic end tube. A thin Kovar ring is disposed between the envelope and the outer periphery of the ceramic end tube. A copper mounting plate having a central opening is secured to the outer end of the ceramic end tube and a cylindrical bellows surrounds the movable contact rod and is secured between the mounting plate and the movable contact rod. Disk-like shields made of copper or nickel are disposed against shoulders on the two contact rods to confine arc products. In a second embodiment of the invention, a ceramic tube is used instead of the flat ceramic end plate.

4 Claims, 3 Drawing Figures



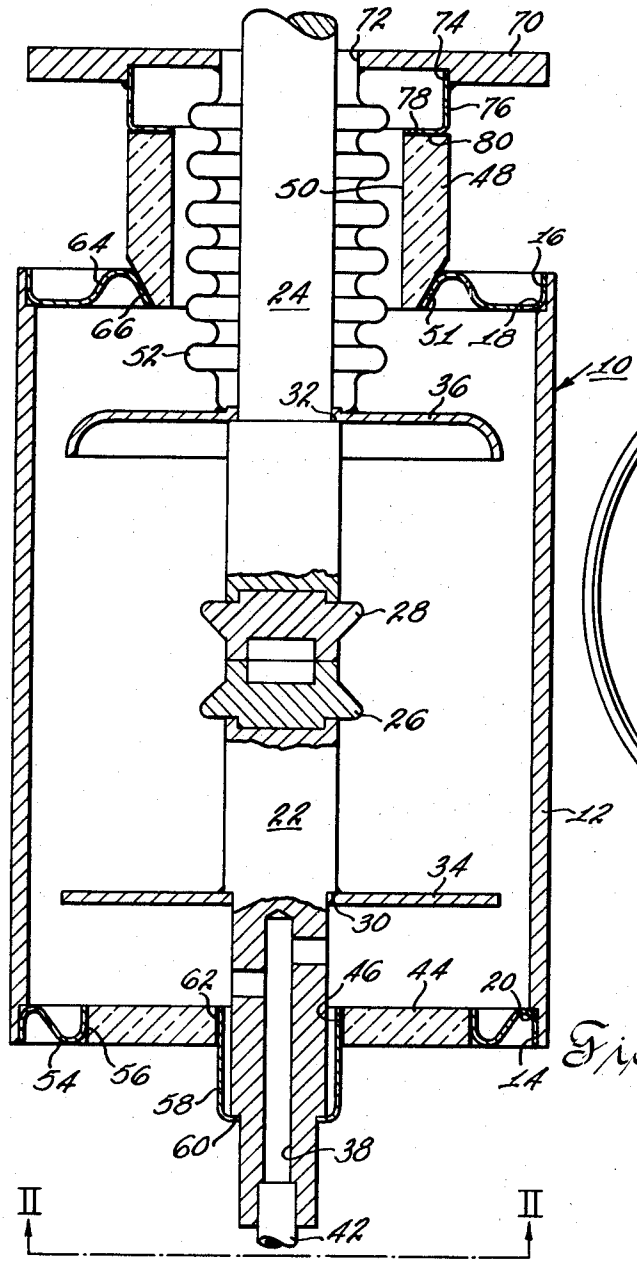


Fig. 1

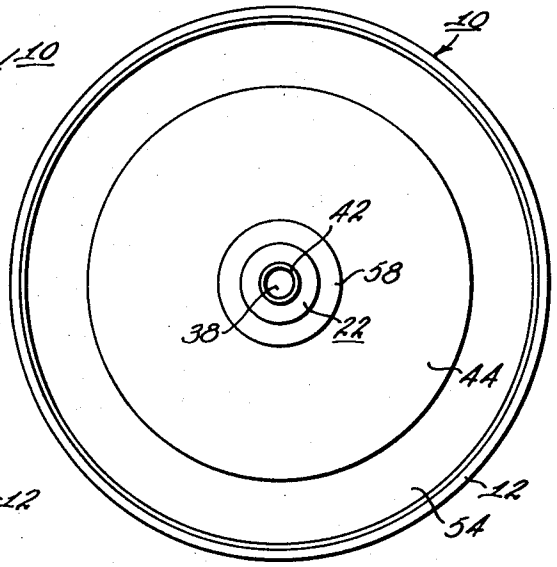


Fig. 2

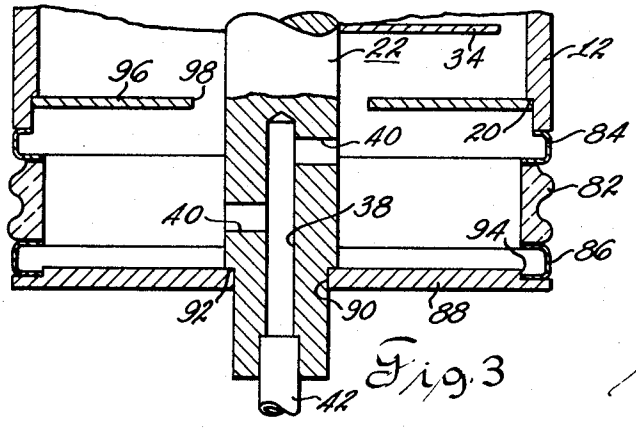


Fig. 3

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VACUUM CIRCUIT INTERRUPTER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to vacuum type electric circuit interrupters. More particularly, it relates to improvements in the construction and arrangement of components comprising the envelope and shielding means in vacuum type circuit interrupters.

2. Description of the Prior Art

Some vacuum type circuit interrupters, especially those designed to interrupt high current, comprise a hollow cylindrical housing of insulation material, such as glass or ceramic, which are closed at its ends by metallic end caps. Contact rods extend into the envelope. In order to prevent vaporized electrode material incident to an arc interruption from condensing on the relatively cool inner surface of the insulating housing, and thereby providing a shunt current path around the electrodes, a metallic arc shield usually separated the electrodes from the inner surface of the insulating housing. For this reason the insulating housings of some prior art vacuum interrupters had a relatively large diameter and were relatively costly.

One prior art vacuum interrupter attempted to solve the foregoing problems by providing a pair of elongated tubular insulating housing portions joined together by a bulbous arcing chamber having a substantially larger diameter than the housing portions. This arcing chamber provided a condensing surface for vaporized contact material and a low thermal conductivity path to atmosphere for the heat generated by the arc. The fabrication of this bulbous chamber is quite difficult and costly and the metal-to-ceramic joints are very close to the arc active region. The presence of such joints, or even metal-to-metal braze joints, lead to electric field concentrations and create possible breakdown hazards.

Still another prior art vacuum interrupter employed an evacuated envelope comprising a pair of elongated, hollow, open-ended insulation members joined by means of a butt seal to an open-ended metallic arcing chamber having a bulbous center portion made of two welded half-spheres and a bulbous metallic arc shield affixed to the arcing chamber and extending toward the opposite ends of the housing. Again, besides the cost involved in forming these bulbous housings, affixing of the arc shield to the inner surface of the arcing chamber, and then welding the two halfs of the arcing chamber is complicated, especially when the shield and the arc chamber are made of materials of different thermal expansion characteristics. The rapid change in temperature as the arc products hit the arc shield, combined with the difference in thermal expansion of the arc shield and bulbous arc chamber, could lead to thermal stress that could eventually crack the weld in the center of the arc chamber. Also, the use of an arc chamber of low thermal conductivity material is undesirable because it hinders the heat flow out of the vacuum interrupter.

SUMMARY OF THE INVENTION

A vacuum type circuit interrupter in accordance with the invention comprises a hollow cylindrical open-ended metallic envelope having relatively movable contact rods extending thereto. A toroidally shaped ceramic insulator is disposed at each end of the envelope and surrounds its associated contact rod. Two expansion rings seal the outer edges of insulators to the envelope. A third expansion ring also seals the space between one insulator and the stationary contact. A metallic end plate or member surrounds the movable contact rod and a fourth expansion ring seals the metallic end plate to its associated ceramic insulator. A flexible sealing means such as a bellows joins the end plate to the movable contact. Disk-type shield means are disposed inside the envelope and are associated with the contact rods.

The metallic envelope serves to effectively condense arc products, rapidly and efficiently dissipate thermal energy from the arc, and provides a large vacuum volume relative to overall interrupter size. Condensation of arc products on the metallic envelope has no effect on electrical conductivity therealong. The insulators electrically isolate energized portions of the interrupter from the envelope. The insulators, the expansion rings and their mechanical joints are relatively far removed from the arcing area where they can be cheaply and effectively shielded by simplified disk-type shield means. The expansion rings seal metallic and ceramic components which have different thermal expansion characteristics serve to reduce mechanical stresses on the vacuum-tight joints caused by heating. Furthermore the minimum use of ceramic materials consistent with maximum electrical insulation requirements and the low temperatures which the ceramic is exposed minimizes gas desorption and effusion problems normally encountered when using ceramic in vacuum type interrupters.

OBJECTS

It is an object of the present invention to provide improved vacuum type circuit interrupters having, relative to their physical size, high arc interrupting capabilities, good thermal energy dissipation characteristics and superior mechanical strength.

Another object is to provide such interrupters which use a minimum amount of ceramic material and have vacuum-tight joints and wherein the ceramic materials and the joints are remote from the arc generation region and are easily protected by shielding from direct exposure to arcing phenomena.

Another object is to provide such interrupters which can be readily assembled from uncomplicated, easily fabricated components and which are reliable in use.

Another object is to provide improved vacuum type circuit interrupters particularly well adapted for the 50 MVA and 4.8 KV class or above.

Other objects and advantages of the invention will hereinafter appear.

BRIEF DESCRIPTION OF THE DRAWING

The accompanying drawing illustrates preferred embodiments of the invention but it is to be understood that the embodiments illustrated are susceptible of modifications with respect to details thereof without departing from the scope of the appended claims.

In the drawing:

FIG. 1 is a cross section view of a vacuum type circuit interrupter in accordance with the present invention;

FIG. 2 is an end elevation view taken along line II—II of FIG. 1; and

FIG. 3 is a cross section view of a modification to the circuit interrupter shown in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2 of the drawing, the numeral **10** designates a vacuum type circuit interrupter in accordance with the invention. Interrupter **10** comprises a hollow constant-diameter cylindrical metallic envelope **12**, preferably fabricated of copper, which has first and second end openings **14** and **16**, respectively, and which is provided with integrally formed annular shoulders **18** and **20** inside the envelope near the end openings **16** and **14**, respectively.

Stationary and movable electrically conductive contact rods **22** and **24**, respectively, extend into envelope **12** through the end openings **14** and **16**, respectively. The rods **22** and **24** are cylindrical in form and preferably formed as by machining from OFHC copper and are provided with contacts **26** and **28**, respectively, which are brazed to their inner ends. The rods **22** and **24** are provided with integrally formed shoulders **30** and **32**, respectively, against which circular or disk-type shields **34** and **36**, respectively, are secured, as by brazing. Stationary contact rod **22** is provided with an axially disposed cylindrical opening **38**, preferably formed by drilling, which extends from the outermost end of the rod to a point which is inside en-

velope 12 and one or more passages 40, also formed by drilling, communicate between the interior of the envelope and opening 38. A hollow, cylindrical metallic vacuum pump-out and pinch-off tube 42 is brazed in place in opening 38. The contact rods 22 and 24 are adapted to have portions exterior of envelope 12 connected in an electrical circuit which is to be controlled.

A first toroidally shaped substantially flat insulating member or end plate 44, preferably formed of vacuum-tight high-grade ceramic, and provided with a centrally located circular opening 46 is disposed at opening 14 in envelope 12 and accommodates stationary contact rod 22 in its opening 46.

A second toroidally shaped substantially cylindrical insulating member or end tube 48, preferably formed of vacuum-tight high-grade ceramic, and provided with a centrally located opening 50 is disposed at opening 16 in envelope 12 and accommodates reciprocably movable contact rod 24 and a flexible sealing meanS, such as a bellows 52, in its opening 50. Tube 48 is provided with a conical or tapered outer surface 51 at its inner end.

A first metallic sealing member or ring 54 is joined or sealed at its edges as by welding between shoulder 20 of envelope 12 and the outer peripheral edge of insulating end plate 44. To facilitate welding, the outer peripheral edge of ceramic end plate 44 is provided with a metalized coating 56. Preferably, sealing member 54 is fabricated of thin Kovar metal or other material having thermal expansion and contraction characteristics similar to the ceramic material of which end plate 44 is made.

A second metallic sealing member or ring 58 in tubular form and of the same composition as sealing member 54 is joined or sealed at its edges as by brazing between the side wall of opening 46 in insulating end plate 44 and a shoulder 60 provided on stationary contact rod 22. The ceramic side wall of opening 46 is provided with a metallized coating 62 to facilitate welding.

A third metallic sealing member or ring 64 is joined or sealed at its edges as by welding between shoulder 18 of envelope 12 and surface 51 of ceramic end tube 48. Ring 64 is of the same composition as the rings 54 and 58 and surface 51 is provided with a metallized coating 66 to facilitate welding.

A metallic end member or plate 70, suitable for use as a mounting plate, and having a central opening 72 and an integrally formed annular shoulder 74 surrounds movable contact rod 24 and is spaced from one end of envelope 12.

A fourth metallic sealing member or ring 76 is joined or sealed at its edges as by brazing between shoulder 74 in end member 70 and the outer end surface 78 of ceramic end tube 48. Surface 78 of end tube 48 is provided with a metallized coating 80 to facilitate brazing.

Flexible metallic sealing means in the form of a tubularly shaped bellows 52 surrounds movable contact rod 24 and is joined as by brazing between end plate 70 and rod 24. Preferably, bellows 52 is secured to the flat rear surface offered by shield 36 adjacent rod 24.

During manufacture the contact rods 22 and 24, their contacts 26 and 28, respectively, and their shields 34 and 36, respectively, comprise sub-assemblies which are jigged in place in envelope 12. Ceramic end plate 44 and the sealing members 54 and 58 comprise another sub-assembly which is placed on contact rod 22 and then secured thereto and to envelope 12. Metal end plate 70, ceramic tube 48, the sealing members 64 and 76, and bellows 52 comprise still another subassembly which is placed on contact rod 24 and then secured thereto and to envelope 12.

FIG. 3 shows a modification of interrupter 10 which employs a tubular ceramic member 82 instead of flat ceramic end plate 44 and tubularly shaped first and second sealing members 84 and 86 instead of the sealing members 54 and 58, respectively, shown in FIGS. 1 and 2. In the modification shown in FIG. 3, a circular metallic end plate 88 having a central hole 90 is disposed against a shoulder 92 on contact rod 22 and brazed in place and ring 86 is brazed to a shoulder 94 on the periphery of end plate 88. Preferably, ceramic tube 82, rings 84 and 86, and plate 88 are of substantially the same diameter as envelope 12. A disk-type shield 96 having a central opening 98 is brazed in place against shoulder 20 in envelope 12.

A vacuum interrupter in accordance with the present invention has numerous advantages. For example, the contact rods, the envelope, the Kovar metal seals, the shields and other components are easily fabricated from commercially available components of standard geometric shape. The shoulders and surfaces at which vacuum-tight seals are made can be readily provided by standard machining techniques. Furthermore, all welds or joints are readily accessible during manufacture because of the order of component arrangement during subassembly and final assembly. All vacuum-tight joints and ceramic components are located remotely from the arcing region and the simple disk-type shields prevent line-of-sight exposure to the arcing region. Thus, the risk of joint damage is substantially reduced. Furthermore, a minimum amount of ceramic material is used and it, too, is shielded against direct exposure to arcing. Consequently, release of absorbed contaminating gases from the ceramic is reduced. The shape of envelope 12 and the arrangement of other components provides a maximum volume in which the vacuum is maintained vis-a-vis the over all size of the unit. And, envelope 12 affords a large surface area of high thermal conductivity for improved heat dissapation.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a vacuum type circuit interrupter,
a hollow cylindrical metallic envelope having first and second end openings;
stationary and movable contact rods extending into said envelope through said first and second end openings, respectively;
contact making means at the ends of said contact rods;
a first disk shaped ceramic insulation member of smaller diameter than said envelope, said first insulation member being disposed in said first end opening of said envelope;
a second ceramic insulation member of tubular configuration located at said second end opening of said envelope;
a first metallic sealing ring joined between said envelope and said first insulation member;
a second metallic sealing ring joined between said first insulation member and said stationary contact;
a third metallic sealing ring joined between said envelope and second insulation member;
a metallic end member spaced from the second end opening of said envelope;
a fourth metallic sealing ring joined between said end member and said second insulation member;
a bellows joined between said endmember and said movable contact rod;
a first disk shaped shield member of greater diameter than said first disk shaped insulation member, said first shield being carried on said stationary rod in spaced relationship to the contact means thereof and to the first disk shaped insulation member; and,
a second saucer shaped shield secured to said movable contact rod in spaced relationship to said second ceramic insulation member and to the contact means of said movable contact rod with the cavity side thereof facing said first shield member in position to intercept arc particles to substantially reduce the deposit of such particles at the sealed joints and on said third seal ring and the second ceramic insulation member.

2. An interrupter according to claim 1 wherein said envelope is provided with internal annular shoulders at each opening thereof; and,
said first and third metallic sealing rings are disposed in sealed engagement with respective ones of said annular shoulders.

3. An interrupter according to claim 2 wherein the end of said second tubular shaped ceramic insulation member nearest said envelope is provided with a conical outer surface against which said third metallic sealing ring abuts in sealing relationship therewith.

4. An interrupter according to claim 1 wherein said first ceramic insulator is of substantially the same external diameter as the diameter of said envelope; and, there is also provided a third shield member of disk shaped configuration which is provided with an axial opening so as to permit the extension of said stationary contact rod into said envelope without physical contact therebetween, said third shield being secured to said envelope and disposed between said first shield member and the adjacent ceramic insulation member to form a labyrinth for the interception of arc particles.

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