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[54] **ARC-SHIELD ARRANGEMENT IN A VACUUM POWER CIRCUIT BREAKER**

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[51] **Int. Cl.²** **H01H 33/66**
[58] **Field of Search** .... 200/144 B

[56] **References Cited**

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[57] **ABSTRACT**

An arc-shield arrangement in a vacuum power circuit breaker which has an interrupter unit which includes a generally cylindrical insulating envelope closed at both ends by end plates, stationary and movable electrode rods projecting into the envelope through one of the end plates, the arrangement protecting the insulating envelope from being contaminated with metal vapor of the arc plasma produced when the movable electrode rod is disconnected from the stationary electrode rod. To permit reduction of the overall dimensions of the insulating envelope, the arc-shield arrangement is adapted to form vacuum gaps in an axial direction of the envelope, in contrast to prior-art arc-shield arrangements in which the gaps are formed annularly about the axis of a vacuum bulb.

6 Claims, 3 Drawing Figures

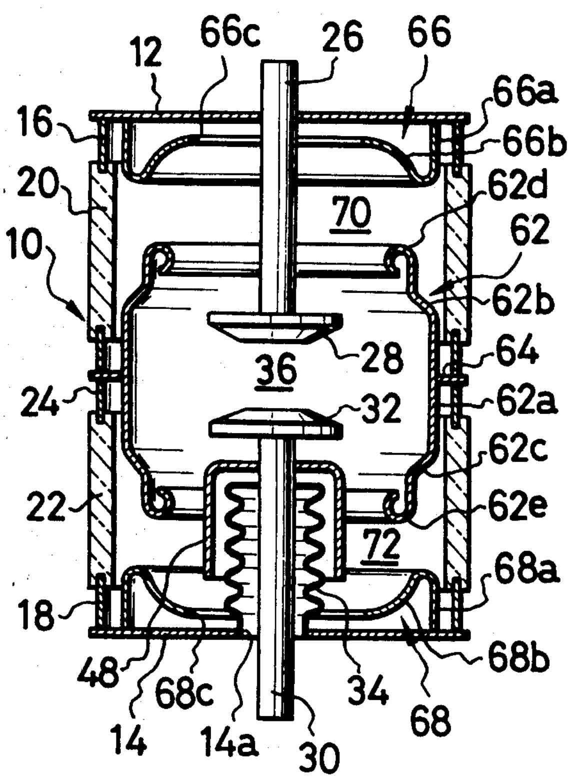


FIG. 3

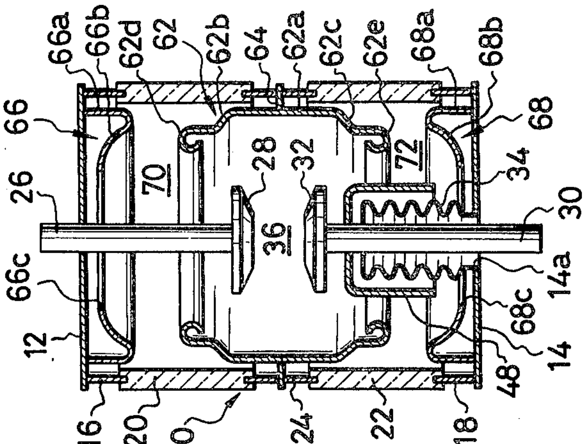


FIG. 2
PRIOR ART

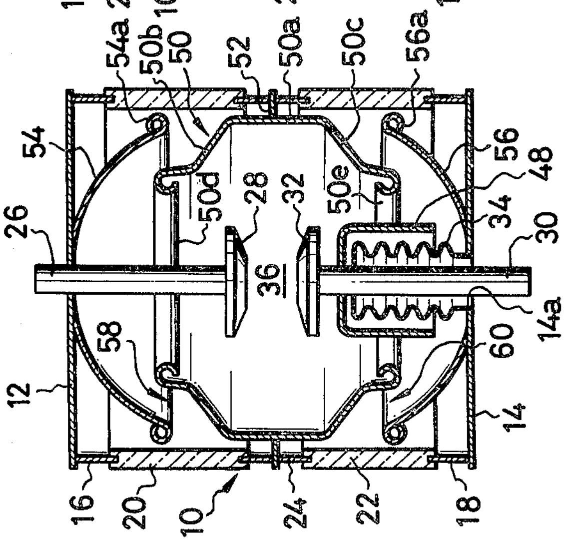
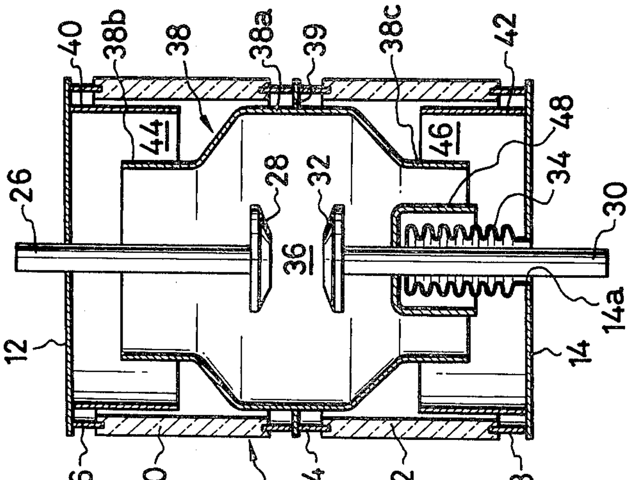


FIG. 1
PRIOR ART



ARC-SHIELD ARRANGEMENT IN A VACUUM POWER CIRCUIT BREAKER

The present invention relates to power circuit breakers and, more particularly, to vacuum power circuit breakers, and arc-shield arrangements therein.

Vacuum power circuit breakers are principally used for polyphase medium-voltage power distribution purposes and generally comprise vacuum-bulb power interrupter units which are respectively allocated to individual phases of the current to be cut off. Each of the vacuum-bulb power interrupter units has a vacuum bulb which is composed of a generally cylindrical insulating envelope usually of glass or ceramics and a pair of metal end plates which are connected to longitudinal ends of the insulating envelope through metal-to-insulation seal elements. Stationary and movable electrode rods axially project into the vacuum bulb through the metal end plates and carry electrical contact elements at their respective leading ends which are located in the neighborhood of an axial center of the vacuum bulb.

When the movable electrode rod is axially moved toward the stationary electrode rod, the electrical contact elements carried on the two electrode rods are brought into contact with each other so that electrical connection is established between the electrode rods. When, conversely, the movable electrode rod is axially moved away from the stationary electrode rod, then the electrical contact elements on the two electrode rods are spaced apart from each other, forming an arcing region between the contact elements. An arc plasma is consequently produced in the arcing region with metal vapor emitted from the cathode electrode. The ions and metal particles forming the arc plasma are rapidly dispersed around the arcing region and disappear as the arc plasma is weakened in the vicinity of a current zero point so that high vacuum is restored in the arcing region, and accordingly the flow of current through the arcing region is interrupted.

In order to improve the insulation restoration characteristics of the vacuum power circuit breaker as a whole and to protect the insulating envelope from being stained with the metal particles forming the arc plasma, the vacuum-bulb power interrupter unit is usually provided with an arc-shield arrangement which consists of one or more generally cylindrical or ring-shaped arc-shield elements which are adapted to cool, condense and thereby capture the metal particles dispersed around the arcing region between the spaced contact elements on the stationary and movable electrode rods.

Where only one arc-shield element is provided in the interrupter unit, the arc-shield element is usually positioned in such a manner that the arc-shield element concentrically surrounds the arcing region and thus forms an annular gap between each of the contact elements and that portion of the arc-shield element which is in axially overlapping but radially spaced relation to the contact element.

Since, in this instance, only one annular gap is formed between the arc-shield element and each of the contact elements, there is a tendency that the electrical potential on the arc-shield element differs from the potential occurring at the center of the arcing region and assumes a value near to the potential on either of the contact elements.

Since, moreover, the spread of the metal vapour tends to be localized toward either of the contact elements immediately after the vapour has been produced between the contact elements, the electrical potential on the arc-shield element is subject to fluctuation in a broad range. All these result in unstable voltage characteristics of the circuit breaker and will thus invite restrikes of the arc between the contact elements although they have been disconnected from each other.

For the purpose of obviating these problems which result from the use of a single arc-shield element, an advanced version of arc-shield arrangement uses a plurality of, usually, two kinds of and three pieces of arc-shield elements. The arc-shield elements of such an arrangement consist of a generally cylindrical main arc-shield element which is in concentrically surrounding relation to the arcing region between the contact elements and a pair of generally ring-shaped auxiliary arc-shield elements which extend axially inwardly from the end plates of the vacuum bulb.

The two auxiliary arc-shield elements have inner end portions which are in axially overlapping and radially spaced relation to axial outer end portions of the main arc-shield element so that an annular gap is formed between each of the auxiliary arc-shield elements and the overlapping outer end portion of the main arc-shield element. The ions and metal particles of the arc plasma produced as a result of the disconnection between the contacts elements are, thus, intercepted in a major proportion by the main arc-shield element but the remaining portion of the arc plasma is allowed to escape from the coverage of the main arc-shield element toward the inner faces of the end plates of the vacuum bulb. The arc plasma allowed out of the main arc-shield element impinges upon the inner faces of the end plates and is caused to spread toward inner peripheral surfaces of the auxiliary arc-shield elements which are respectively located adjacent to the end plates.

In order that the vapor of the ions and metal particles thus spreading away from the end plates of the vacuum bulb be reliably and efficiently intercepted by the arc-shield elements, it is of importance that each of the auxiliary arc-shield elements be in axially overlapping and radially spaced relation over a sufficient area to the adjacent outer end portion of the main arc-shield element so that an annular gap having an ample space is formed between the main arc-shield element and each auxiliary arc-shield element. Formation of such a gap apparently results in increased axial length and diameter of the insulating envelope and accordingly in an enlarged overall construction and an increased production cost of the interrupter unit as a whole.

The present invention contemplates the elimination of all these drawbacks of the prior art vacuum power circuit breakers and it is, accordingly, an important object of the present invention to provide an arc-shield arrangement in a vacuum power circuit breaker that contributes to the reduction of the diameter and the axial length of the vacuum bulb and accordingly to the reduction of the production cost of the circuit breaker.

It is another important object of the present invention to provide a vacuum power circuit breaker which has excellent voltage characteristics.

In accordance with the present invention, these and other objects are accomplished in a vacuum power circuit breaker which comprises the inventive arc-shield arrangement, wherein the circuit breaker includes a vacuum-bulb power interrupter unit including a generally cylindrical insulating envelope and a pair of end plates connected to axial ends of the insulating envelope through respective seal elements, a stationary electrode rod axially projecting into the envelope through one of the end plates of the bulb, a movable electrode rod axially projecting into the insulating envelope through the other of the end plates and axially movable toward and away from the stationary electrode rod.

The, stationary and movable electrode rods extend substantially in line with each other and carry electrical contact elements at their respective leading end portions for providing an arcing region between the contact elements when the movable electrode rod is axially moved away from the stationary electrode rod.

The inventive arc-shield arrangement is characterized by a main arc shield element having an axially central cylindrical portion which is in concentrically surrounding relationship to and radially spaced apart from the arcing region between the two contact elements and axially outer end portions which extend axially outwardly from the central cylindrical portion and are respectively in concentrically surrounding relationship to leading end portions of the electrode rods.

There is a pair of auxiliary arc-shield elements respectively mounted on the inner faces of the end plates, each arc-shield element having a generally cylindrical portion projecting axially inwardly from the inner face of the associated end plate and extending in proximity to and parallel with the inner peripheral surface of the seal element adjacent to the end plate.

There is furthermore an annular portion extending radially inwardly and axially toward the inner face of the associated end plate from an axially inner end of the cylindrical portion of the auxiliary arc-shield element, each of the latter being axially spaced apart from each of the axial ends of the main arc-shield element, and forming an axial gap between each axial end main arc-shield element and each of the arc-shield elements.

The axially outer end portions of the main arc-shield element may be made substantially smaller in diameter than the axially central portion of the main arc-shield element. To impede the formation of sparks around the axially outer end portions of the main arc-shield element, each axially outer end portion of the main arc-shield element may have a circumferential edge which is rounded into a hoop form.

The features and advantages of the vacuum power circuit breaker according to the present invention over the prior-art counterparts will be better understood from the following description taken in conjunction with the accompanying drawings, in which like reference numerals and characters designate corresponding units, members and portions, and in which:

FIG. 1 is a longitudinal sectional view which sown an example of a prior-art vacuum-bulb power interrupter unit of a vacuum circuit breaker, using a plurality of arc-shield elements;

FIG. 2 is a view similar to FIG. 1 showing another example of the prior-art vacuum-bulb power interrupter unit, using a plurality of arc-shield elements; and

FIG. 3 is a longitudinal sectional view which schematically illustrates a preferred embodiment of a vacuum-bulb power interrupter unit according to the present invention.

Reference will now be made to the drawings, first to FIG. 1 so as to more clearly point out the drawbacks inherent in a prior-art vacuum-bulb power interrupter unit incorporating an arc-shield arrangement which consists of two kinds of and three pieces of arc-shield elements.

As shown in FIG. **1**, a vacuum-bulb power interrupter unit of a known vacuum circuit breaker includes a vacuum bulb which is composed of a generally cylindrical insulating envelope **10** and a pair of, upper and lower, metal end plates **12** and **14** to which the insulating envelope **10** is securely and hermetically connected at its axial ends through metal-to-insulation seal elements **16** and **18**, respectively, which form part of the insulating envelope **10.** The insulating envelope **10** is herein shown as comprising a pair of cylindrical members **20** and **22** of usually glass or ceramics. The two cylindrical members **20** and **22** are connected at their axially outer ends to the upper and lower end plates **12** and **14** through the seal elements **16** and **18**, respectively, and at their axially inner ends to each other through a ring-shaped connecting member **24.**

A stationary electrode rod **26** axially projects into the vacuum bulb through the upper end plate **12** and carries at its leading end an electrical contact element **28.** The stationary electrode rod **26** is fixed to the vacuum bulb or otherwise to a suitable stationary member or structure which is independent of the vacuum bulb and is electrically connected to a leading-in line of the vacuum power circuit breaker.

The lower end plate **14** of the vacuum bulb is formed with a central aperture **14***a* through which a movable electrode rod **30** axially projects into the vacuum bulb. The movable electrode rod **30** extends in line with the stationary electrode rod **26** and carries at its leading end an electrical contact element **32** similarly to the stationary electrode rod **26.** The movable electrode rod **30** is electrically connected to a leading-out line of the vacuum circuit breaker and is mechanically connected to an actuating member of a control mechanism which is usually located below the interrupter unit, though not shown. The movable electrode rod **30** is thus driven by the control mechanism to axially move toward and away from the stationary electrode rod **26** so that electrical connection is established or interrupted between the contact elements **28** and **32** on the stationary and movable electrode rods **26** and **28**, respectively. The central aperture **14***a* in the lower end plate **14** of the vacuum bulb is sealed off by means of a metallic bellows assembly **34** which is connected between the end plate **14** and the movable electrode rod **30.**

When the movable electrode rod **30** is axially moved toward the stationary electrode rod **26**, the contact element **32** on the movable electrode rod **30** is brought into contact with the contact element **32** on the stationary electrode rod **26** so that electrical connection is established between the two electrode rods **26** and **30.** When, conversely, the movable electrode rod **30** is axially moved away from the stationary electrode rod **26,** then the contact element **32** on the former is spaced apart from the contact element **28** on the latter so that an arcing region **36** is provided between the spaced contact elements **28** and **32.**

To protect the insulating envelope **10** from being contaminated with the metal vapour of the arc thus produced, the vacuum-bulb power interrupter unit has incorporated into the vacuum bulb an arc-shield arrangement which is shown to comprise a main arc-shield element **38** supported by the connecting member **24** through an annular support member **39** and a pair of cylindrical auxiliary arc-shield elements **42** and **44** which are supported by the upper and lower end plates **12** and **14**, respectively, of the vacuum bulb.

The main arc-shield element **38** has an axially intermediate portion **38***a* which is in concentrically surrounding and radially spaced relation to the arcing region **36** or, in other words, to the contact elements **28** and **32** in the spaced apart conditions shown and upper and lower end portions **38***b* and **38***c*, respectively, which extend axially outwardly from the intermediate portions **38***a* and which are in concentrically surrounding and radially spaced relation to inner or leading end portions of the stationary and movable electrode rods **26** and **30**, respectively. The intermediate portion **38***a* of the main arc-shield element **38** is radially in proximity to the inner surface of the insulating envelope **10** whereas the upper and lower end portions **38***b* and **38***c* of the main arc-shield element **38** have reduced diameters and are thus radially inwardly spaced apart from the inner surface of the insulating envelope **10.**

On the other hand, the upper and lower auxiliary arc-shield elements **40** and **42** extend axially inwardly from the inner faces of the upper and lower end plates **12** and **14,** respectively, and have axially inner end portions which are in concentrically surrounding and radially spaced relation to the reduced upper and lower end portions **38***b* and **38***c*, respectively. An annular gap **44** is thus formed between the upper end portion **38***b* of the main arc-shield element **38** and the lower end portion of the upper auxiliary arc-shield element **40** and, likewise, an annular gap **46** is formed between the lower end portion **38***c* of the main arc-shield element **38** and the upper end portion of the lower auxiliary arc-shield element **42,** as illustrated. Designated by reference numeral **48** is a generally cupshaped bellows shield element which is supported by the movable electrode rod **30** for the purpose of protecting the bellows assembly **34** from arc plasma.

With the arc-shield elements thus arranged, a major portion of the arc plasma produced between the contact elements **28** and **32** when the movable electrode rod **30** is moved away from the stationary electrode rod **26** is intercepted by the main arc-shield element **38** so that the metal particles of the plasma are largely captured by the main arc-shield element **38.** The remaining portion of the arc plasma is, however, not captured by the main arc-shield element **38** and is thus allowed out of the main arc-shield element **38** toward the upper and lower end plates **12** and **14** through the open axial ends of the main arc-shield element **38.**

The metal particles of arc plasma thus allowed out of the main arc-shield element **38** impinge upon the inner faces of the upper and lower end plates **12** and **14** and are partly re-directed toward the annular gaps **44** and **46** between the upper and lower end portions **38***b* and **38***c* of the main arc-shield element **38** and the axially overlapping portions of the upper and lower auxiliary arc-shield elements **40** and **42.** The insulating envelope **10** is in this manner shielded from the arc plasma primarily by the main arc-shield element **38** and secondarily by the auxiliary arc-shield elements **40** and **42.** In order that the insulating envelope **10** be reliably isolated from the arc plasma, it is important that the annular gaps **44** and **46** have sufficient axial lengths which will give rise to an increase in the axial length of the vacuum bulb.

Since, moreover, the gaps **44** and **46** are formed annularly about an axis of the vacuum bulb, the insulating envelope **10** should have a diameter which is large enough to provide sufficient radial spacings between the main arc-shield element **38** and the auxiliary arc-shield elements **40** and **42.** The thus increased axial length and diameter of the vacuum bulb results in an enlarged unwieldy overall construction and an increased production cost of the vacuum-bulb power interrupter unit is previously noted.

These drawbacks are to some extent alleviated in an arc-shield arrangement incorporated into the vacuum-bulb power interrupter unit which is illustrated in FIG. **2.** Referring to FIG. **2,** this advanced version of a prior-art arc-shield arrangement comprises, in addition to the bellows shield element **34,** a main arcshield element **50** which is supported by the connecting member **24** of the insulating envelope **10** through an annular support member **52** and a pair of auxiliary arc-shield elements **54** and **56** supported by the upper and lower end plates **12** and **14,** respectively, of the vacuum bulb.

The main arc-shield element **50** has an axially intermediate portion **50***a* which is in concentrically surrounding and radially spaced relation to the arcing region **36,** viz., to the electrical contact elements **28** and **32** in the spaced apart conditions and upper and lower end portions **50***b* and **50***c* which extend axially outwardly and radially inwardly from the intermediate portion **50***a* and which are in concentrically surrounding and radially spaced relation to the inner or leading end portions of the stationary and movable electrode rods **26** and **30,** respectively. To impede the production of sparks around the open ends of the main arc-shield **50,** the upper and lower end portions **50***b* and **50***c* of the main arc-shield **50** have circumferential edges **50***d* and **50***e*, respectively, each of which is rounded into a hoop form as illustrated.

On the other hand, the auxiliary arc-shield elements **54** and **56** have generally arcuate cross sections and are secured at their top and bottom to the inner faces of the upper and lower end plates **12** and **14,** respectively. The upper and lower auxiliary arc-shield elements **54** and **56** thus have respective inner faces which are concave to the adjacent axial ends of the main arc-shield element **50.**

The auxiliary arc-shield elements **54** and **56** have skirt portions **54***a* and **56***b*, respectively, which are also rounded into loop forms so as to prevent the formation of sparks therearound. These rounded skirt portions **54***a* and **56***b* of the upper and lower auxiliary arc-shield elements **54** and **56,** respectively, are in concentrically surrounding and radially outwardly spaced relation to the rounded edge portions **50***d* and **50***e* of the main arc-shield element **50.** An annular gap **58** is thus formed between the rounded upper edge portion **50***d* of the main arc-shield element **50** and the rounded skirt portion **54***a* of the upper auxiliary arc-shield element **54** and, likewise, an annular gap **60** is formed between the rounded lower edge portion **50***e* of the main arc-shield element **50** and the rounded skirt portion **56***a* of the lower auxiliary arc-shield element **56,** as shown.

Since, thus, the gaps **58** and **60** are formed annularly about the axis of the vacuum bulb, the main and auxiliary arc-shield elements should have sufficient axial lengths and, besides, the auxiliary arc-shield elements should have sufficient diameters for providing ample spaces to accomodate the gaps **58** and **60.** The drawbacks inherent in the interrupter unit illustrated in FIG. **1** are therefore also encountered in the interrupter unit shown in FIG. **2** although the latter may have an axial length which is shorter relative to the diameter than that of the former. The gist of the present invention consists in the provision of an axial gap, in lieu of the annular gap, between the main arc-shield element and each of the auxiliary arc-shield elements so as to permit significant reduction of the diameter and the axial length of the interrupter unit.

Referring to FIG. **3,** the inventive arc-shield arrangement herein proposed is shown as being incorporated into a vacuum bulb which in itself is similar in construction to a prior-art vacuum bulb, which may be constructed as illustrated in FIGS. **1** or **2.** The description made in respect of the construction of the vacuum-bulb power interrupter unit illustrated in FIG. **1** thus applies as it is to the embodiment of FIG. **3** except for the arc-shield arrangement incorporated therein. It is, however, to be noted that the arc-shield arrangement of the nature herein proposed may be applied to a vacuum-bulb power interrupter having any other construction.

As seen in FIG. **3,** the novel arc-shield arrangement, which forms part of the vacuum-bulb power interrupter unit of the vacuum circuit breaker, embodying the present invention comprises a main arc-shield element **62** which is supported by the connecting member **24** of the insulating envelope **10** through an annular support member **64** and a pair of, upper and lower, auxiliary arc-shield elements **66** and **68** which are supported directly by the upper and lower metal end plates **12** and **14,** respectively, of the vacuum bulb.

The main arc-shield element **62** has a generally cylindrical, axially intermediate portion **62***a* and upper and lower end portions **62***b* and **62***c* extending axially outwardly and radially inwardly from the intermediate portion **62***a*. The cylindrical intermediate portion **62***a* of the main arc-shield element **62** is in concentrically surrounding and radially outwardly spaced relation to the arcing gap **36** or, in other words, to the electrical contacts **28** and **32,** in axially spaced conditions, on the stationary and movable electrode rods **26** and **30,** respectively. On the other hand, the upper and lower end portions **62***b* and **62***c* of the main arc-shield element **62** are in concentrically surrounding and radially spaced relation to inner or leading end portions of the stationary and movable electrode rods **26** and **30.**

The lower end portion **62***c* is also in concentrically surrounding relation to the bellows shield element **48** which contains therein part of the bellows assembly **34.** While the intermediate portion **62***a* of the main arc-shield element **62** is located radially in proximity to the insulating envelope **10,** the upper and lower end portions **62***b* and **62***c* of the arc-shield element **62** have reduced diameters and are thus radially spaced apart from the insulating envelope **10** as shown.

The upper and lower end portions **62***b* and **62***c* of the main arc-shield element **62** are, moreover, shown to have circumferential edges **62***d* and **62***e*, respectively, each of which is rounded into a hoop form so as to impede production of sparks from the edge. The upper auxiliary arc-shield element **66** has a cylindrical portion **66***a* extending axially inwardly from the inner face of the upper end plate **12** of the vacuum bulb and radially in close proximity to the metal-to-insulation seal element **16** between the upper and plate **12** and the insulating envelope **10** and having an axial length which is appreciably larger than an axial length of the seal element **16.**

The upper auxiliary arc-shield element **66** further has an annular portion **66***b* extending radially inwardly and axially outwardly from the cylindrical portion **66***a* and having an inner peripheral edge which is in concentrically surrounding and radially spaced relation to the stationary electrode rod **26.** The annular portion **66***b* of the upper auxiliary arc-shield element **66** thus has an inner circumferential edge **66***c* encircling the stationary electrode rod **26** and a concave inner face confronting the upper end of the main arc-shield element **62.** A gap **70** is thus formed axially between the upper end of the main arc-shield element **62** and the upper auxiliary arc-shield element **66.**

The lower auxiliary arc-shield element **68** is shaped similar to the upper auxiliary arc-shield element **66,** having a generally cylindrical portion **68***a* extending axially inwardly from the lower end plate **14** and extending close to and appreciably longer than the seal element **18** and an annular portion **68***b* extending radially inwardly and axially outwardly from the cylindrical portion **68***a* and having an inner circumferential edge **68***c* encircling the movable electrode rod **30** and accordingly the bellows assembly **34** and a concave inner face which confronts the lower end of the main arc-shield element **62.** A gap **72** is thus formed axially between the lower end of the main arc-shield element **62** and the lower auxiliary arc-shield element **68.**

The ions and metal particles of arc plasma produced in the arcing region **36** when the movable electrode rod **30** is moved away from the stationary electrode **26** are captured in a major proportion by the main arc-shield element **62.** The remaining portion of the arc plasma which is allowed out of the main arc-shield element **62** through the upper and lower open ends thereof is partly admitted into annular spaces between the upper and lower end plates **12** and **14** and the annular portions **66***b* and **68***b* of the upper and lower auxiliary arc-shield elements **66** and **68,** respectively, through the central apertures defined by the inner circumferential edges **66***c* and **68***c* and partly impinges upon the concave inner faces of the annular portions **66***b* and **68***b* so as to be captured in part by the auxiliary arc-shield elements **66** and **68** and in part re-directed from the concave surfaces of the elements backwardly into the space which is defined by the main arc-shield element **62.**

While the annular portions **66***b* and **68***b* of the auxiliary arc-shield elements **66** and **68,** respectively, are effective to capture or re-direct the arc plasma, the cylindrical portions **66***a* and **68***a* of the elements **66** and **68** serve to lessen the strength of the electric fields which tend to be concentrated around the metal-to-insulation seal elements **16** and **18.**

Where desired, the cylindrical portions **66***a* and **68***a* of the auxiliary arc-shield elements may merge into the annular portions **66***b* and **66***c* through edge portions which are curved so as to further lessen the strength of the electric fields around the seal elements **16** and **18** and thereby to prevent production of sparks around the seal elements **16** and **18.** The axial length of each of the gaps **70** and **72** should be selected in such a manner as to provide a proper withstand voltage between the main arc-shield element **62** and each of the upper and lower auxiliary arc-shield elements **66** and **68.**

From the foregoing description, it will now be appreciated that the following advantages can be achieved in a vacuum power circuit breaker according to the present invention by virtue of the arc-shield arrangement of the described nature:

a. Because of the fact that the main arc-shield element **62** is not axially overlapping relation to the auxiliary arc-shield elements **66** and **68,** the axial lengths of the main and auxiliary arc-shield elements and the diameters of the auxiliary arc-shield elements can be significantly reduced so that providing small-sized overall construction of the vacuum bulb. As a matter of fact, it has been asertained that the diameter of the vacuum bulb of the construction shown in FIG. **3** can be reduced approximately **20** per cent from that of the vacuum bulb incorporating the arc-shield arrangement of, for example, the nature illustrated in FIG. **1** or **2.**

b. In spite of the fact that the gaps providing the necessary withstand voltages between the main and auxiliary arc-shield elements are formed in the axial direction of the vacuum bulb, the axial length of the vacuum bulb need not be increased but, contrariwise, can be considerably reduced. This is because of the fact that each of the auxiliary arc-shield elements has a portion located in proximity to the seal element and a portion effective to re-direct the arc plasma into the main arc-shield element so that the field strength to which the seal element is to be subjected can be effectively alleviated.

c. By virtue of the significant reduction of the axial lengths of the main and auxiliary arc-shield elements and the diameter of the auxiliary arc-shield elements, the costs for the production and installation of the vacuum power circuit breaker can be reduced to a considerable degree.

While only one preferred embodiment of the arc-shield arrangement, in a vacuum power circuit breaker, according to the present invention has been described and shown, such is merely for the purpose of illustration of the essential features of the present invention and is therefore subject to various changes and modifications where desired.

What is claimed is:

1. An arc-shield arrangement in a vacuum power circuit breaker which includes a vacuum-bulb power interrupter unit including a generally cylindrical insulating envelope and a pair of end plates connected to axial ends of said envelope through respective seal elements, a stationary electrode rod axially projecting into said envelope through one of said end plates, and a movable electrode rod axially projecting into said envelope through the other of said end plates and axially movable toward and away from said stationary electrode rod, said electrode rods extending substantially in line with each other and carrying electrical contact elements at their respective leading end portions for providing an arcing region between said contact elements when said movable electrode rod is axially moved away from said stationary electrode rod, the arrangement comprising a main arc-shield element having an axially central cylindrical portion which is in concentrically surrounding relationship to and radially spaced apart from said arcing region and axially outer end portions which extend axially outwardly from said central cylindrical portion and are respectively in concentrically surrounding relationship to said leading end portions of the electrode rods, and a pair of auxiliary arc-shield elements respectively mounted on the inner faces of said end plates, said auxiliary arc-shield elements having generally cylindrical portions projecting axially inwardly from said inner faces of the associated end plates and extending in proximity to and parallel with the inner peripheral surfaces of said seal elements adjacent to said end plates, annular portions extending radially inwardly and axially toward said inner faces of the associated end plates from axially inner ends of said cylindrical portions of the auxiliary arc-shield elements, the latter being axially spaced apart from the respective axial ends of said main arc-shield element, and forming an axial air gap between said axial ends of the main arc-shield element and said auxiliary arc-shield elements.

2. The arc-shield arrangement as defined in claim **1,** wherein said annular portions of the auxiliary arc-shield elements have concave faces confronting said axial ends of the main arc-shield element.

3. The arc-shield arrangement as defined in claim **2,** wherein said annular portions of the auxiliary arc-shield elements are formed with apertures defined by inner edges encircling that portion of one of said electrode rods which is close to said inner faces of the end plates on which a respective one of said auxiliary arc-shield elements is mounted.

4. The arc-shield arrangement as defined in claim **3,** wherein said cylindrical portions of the auxiliary arc-shield elements extend beyond the axially inner ends of the respective seal elements adjacent thereto.

5. The arc-shield arrangements as defined in claim **4,** wherein said outer end portions of the main arc-shield element are smaller in diameter than said central cylindrical portion thereof.

6. The arc-shield arrangement as defined in claim **5,** wherein said outer end portions of the main arc-shield element have radially inwardly rolled circumferential ends.

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