United States Patent [19]

Hundstad

[11] **3,845,262**

[45] **Oct. 29, 1974**

[54] **CONTACT STRUCTURES FOR VACUUM-TYPE CIRCUIT INTERRUPTERS HAVING CANTILEVERED-SUPPORTED ANNULARLY-SHAPED OUTER ARC-RUNNING CONTACT SURFACES**

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[73] Assignee: **Westinghouse Electric Corporation,** Pittsburgh, Pa.

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[21] Appl. No.: **249,991**

[52] **U.S. Cl.** ..... **200/144 B,** 200/166 BH

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

[58] **Field of Search** ..... 200/144 B, 166 BH

[56] **References Cited**

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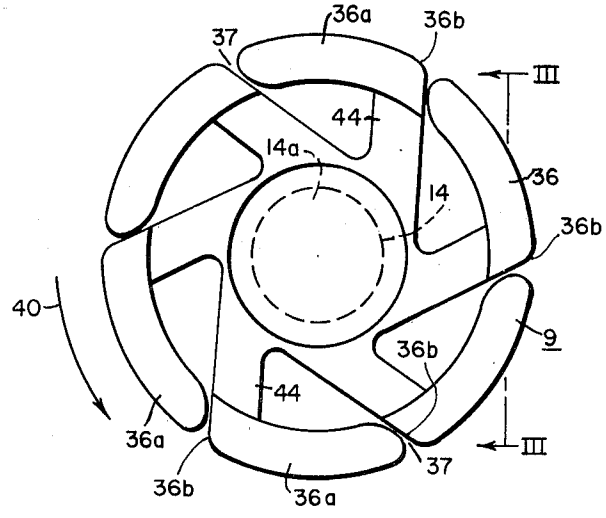
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Attorney, Agent, or Firm—W. R. Crout

[57] **ABSTRACT**

A vacuum-type circuit interrupter is provided having one, or both separable contact structures provided with outwardly-extending spokes, or contact-bars, which support, by cantilever action, annularly-shaped segmented outer arc-running contact surfaces. The arc is initiated at the generally outer annularly-shaped arc-running surfaces, and is rotated thereabout by the magnetic fields generated from the direction of current flow. The arc rotates about the annularly-shaped arc-running surface until interrupted.

8 Claims, 11 Drawing Figures



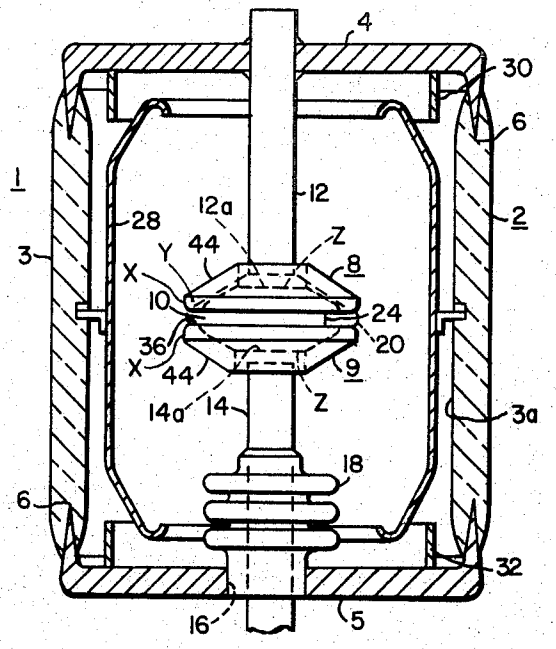
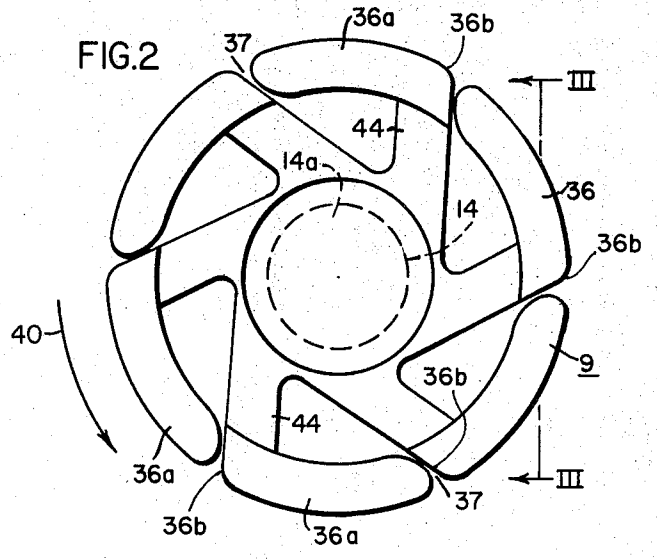


FIG.1

FIG.2



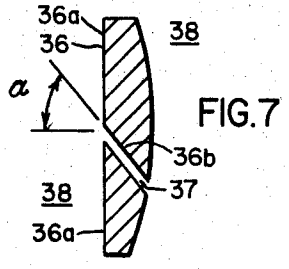


FIG.7

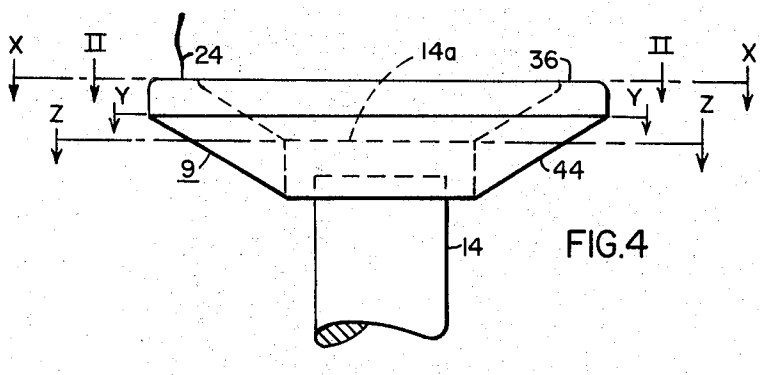


FIG.4

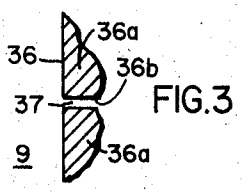


FIG.3

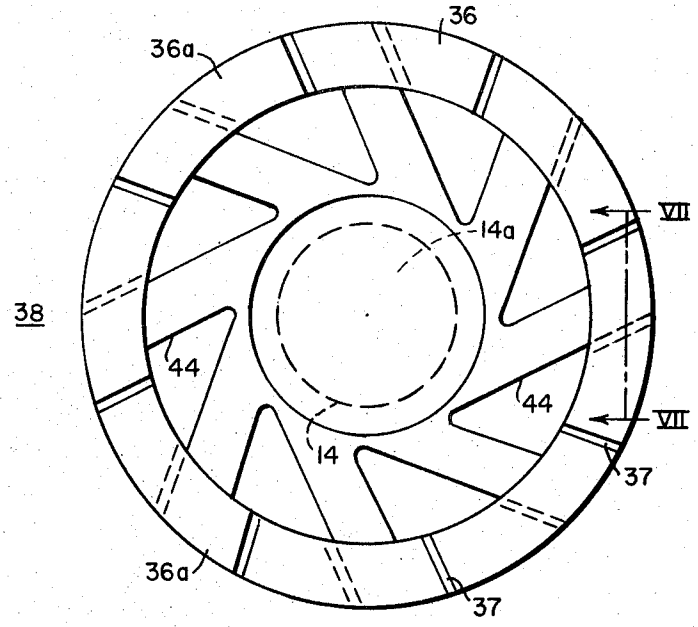

36
36a
VII
14a
38
44
44
VII
14
37
36a
37

FIG.5

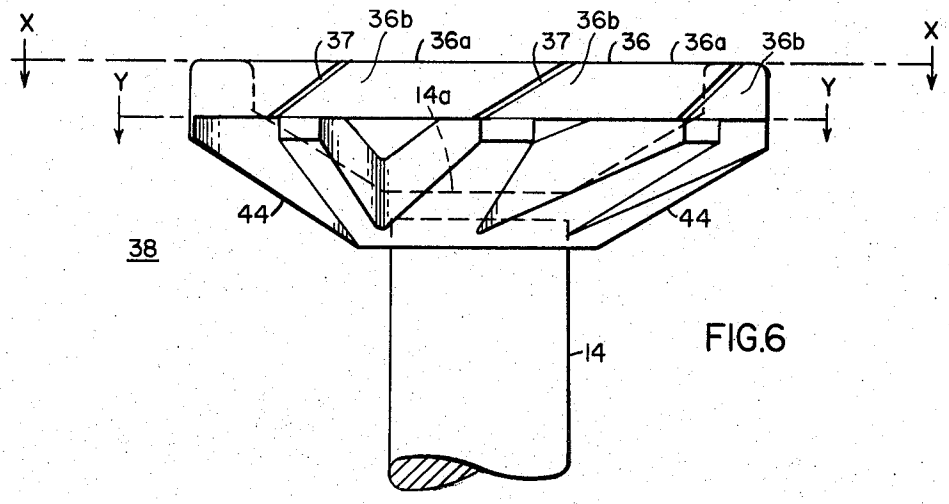

X
36b
37
36a
37
36b
36
36a
36b
X
Y
Y
14a
44
44
38
14

FIG.6

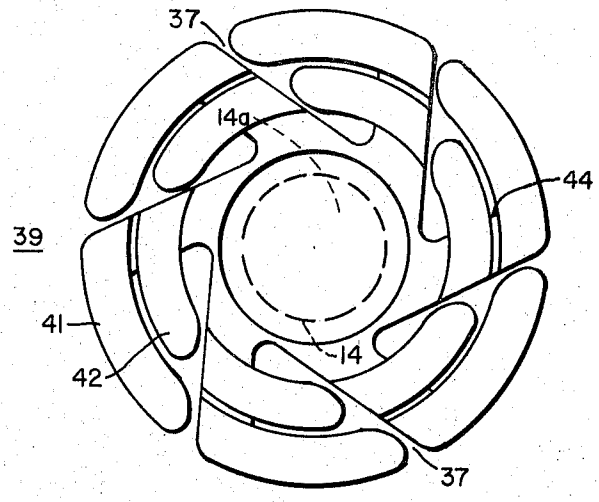
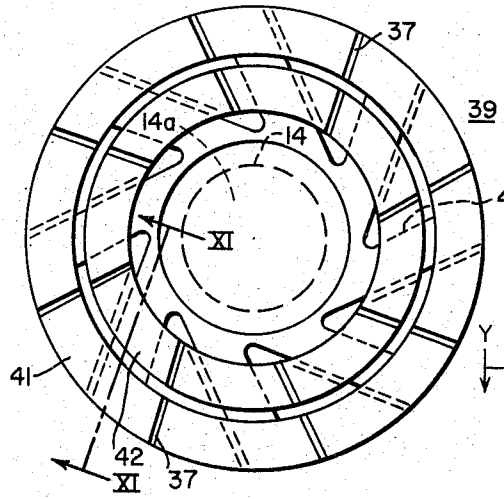


FIG.8

FIG.9



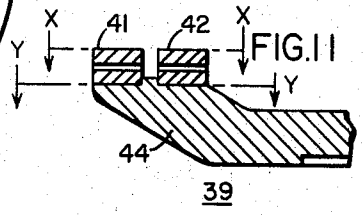


FIG.11

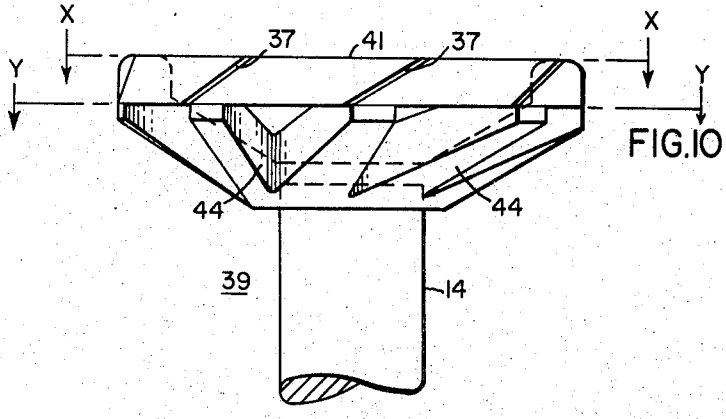


FIG.10

CONTACT STRUCTURES FOR VACUUM-TYPE CIRCUIT INTERRUPTERS HAVING CANTILEVERED-SUPPORTED ANNULARLY-SHAPED OUTER ARC-RUNNING CONTACT SURFACES

CROSS-REFERENCES TO RELATED APPLICATIONS

Reference may be made to U.S. Pat. application filed may 3, 1972 by Richard L. Hundstad, Ser. No. 249,990 , entitled, "Vacuum-Type Circuit Interrupter Having Improved Contacts". Also, reference may be made to U.S. Pat. application filed June 20, 1972, Ser. No. 264,700, by the same inventor entitled "Vacuum-Interrupter Contacts Having Energy-Dissipation Surfaces" and a divisional Pat. application thereof, filed by Richard L. Hundstad on Feb. 12, 1974, S.N. 441,925 with the same title, all of the foregoing applications being assigned to the same assignee as the instant patent application.

BACKGROUND OF THE INVENTION

It has been customary, in the design of contact structures for vacuum-type circuit interrupters, to provide contacts, or electrodes, which are configured with a centrally-provided recess, as set forth in U.S. Pat. No. 2,949,520, issued Aug. 16, 1960, to Harold N. Schneider. The arc in Schneider is initiated at the annular ridge surrounding the centrally-disposed contact recess, and because of the provision of generally-radially-directed slots, which extend radially, and also azimuthally, the arc rotates around the contacts until interruption. One difficulty with the foregoing contact design of Schneider is that the arc moves too rapidly too far towards the arc shield, which invariably is used, being spaced radially outwardly from the separable contact structure to prevent the deposition of metallic vapors upon the inner surfaces of the outer insulating casing walls.

As well known by those skilled in the art, flashover across the vacuum-type circuit interrupter, or "bottle," takes place if, due to deposition of metallic vapors on the inner walls of the outer insulating envelope, the impressed voltage is sufficient to cause breakdown in the open-circuit position of the interrupter. It is, accordingly, undesirable to permit the arc to move radially outwardly too far, since this may cause a hole to be burned through the surrounding spaced metallic condensing shield, which is, of course, undesriable.

SUMMARY OF THE INVENTION

According to the present invention, one or both of the contact structures is provided with outwardly-extending spoke portions, which support, through cantilever action, annularly-shaped outer disposed segmented arc-running contact portions, which, additionally, inherently provide some flexibility. The arc is initially established at the outer annularly-shaped contact surfaces, and moves azimuthally, or cimcumferentially around the contact surfaces with very little concomitant radial movement. Accordingly, there is only a weak outward component of the electromagntic force acting upon the arc.

Accordingly, it is a general object of the present invention to provide an improved contact structure for a vacuum-type circuit interrupter.

A more specific object of the present invention is to provide an improved contact, or electrode structure for a vacuum-type circuit interrupter utilizing generally outwardly-extending spokes, or contact bars, which support, due to cantilever action, annularly-shaped, outer disposed arc-running surfaces of segmented construction.

Still a further object of the present invention is the provision of an improved electrode, or contact structure for a vacuum-type circuit interrupter in which purely a rotation of the arc ensues, with a minimum of radial outward arc movement toward the vapor-condensing shield.

Still a further object of the present invention is the provision of an improved circuit interrupter having a pair of separable contacts, each of which does not have a central electrode contact button, as usually provided, but merely annularly, or ring-shaped outer disposed contact surfaces.

Still a further object is the provision of an improved circuit interrupter of the type set forth in the immediately-preceding paragraph, in which flexibility is provided for weldbreaking action.

Further objects and advantages will readily become apparent upon reading the following specification, taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a vertical sectional view of a vacuum-type circuit interrupter embodying the contact construction of the present invention, the contacts being shown in full lines in the open-circuit position;

FIG. **2** is an enlarged top plan view taken over one of the contact structures, as generally indicated by the line II—II of FIG. **4** of the drawings,

FIG. **3** is a fragmentary sectional view taken substantially along the line III—III of FIG. **2**;

FIG. **4** is an enlarged side-elevational view of one of the contact structures utilized in the improved vacuum-type circuit interrupter of FIG. **1**;

FIG. **5** is a top plan view of a modified-type of moving contact, which could be substituted for that of FIG. **1**, drawn to an enlarged scale;

FIG. **6** is a side-elevational view of the modified-type contact of FIG. **5**;

FIG. **7** is a fragmentary sectional view taken substantially along the line VII—VII of FIG. **5**;

FIG. **8** illustrates a modified-type contact having double arc-running contact surfaces;

FIG. **9** illustrates a further modified-type contact with double arc-running contact surfaces and slanting slots therebetween;

FIG. **10** is a side elevational view of the contact of FIG. **9**; and,

FIG. **11** is a fragmentary sectional view taken along the line XI—XI of FIG. **9**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the vacuum-type circuit interrupter of FIG. **1**, generally designated by the reference numeral **1**, there is shown a highly-evacuated envelope **2** comprising a casing **3** of suitable insulating material, and a pair of metallic end caps **4** and **5**, closing off the ends of the casing **2**. Suitable seals **6** are provided between the end caps and the casing **2** to render the envelope vacuum-tight. The normal pressure within the envelope

2, under static conditions, is lower than 10^{-4} torr; so that reasonable assurance is had that the mean free path for electrons will be longer than the potential breakdown paths with the envelope 2.

Located within the envelope 2 is a pair of relatively-movable cup-shaped contacts, or electrodes 8 and 9, shown in full lines in FIG. 1 in their separated, or open-circuit position. When the contacts 8, 9 are separated, there is an arcing gap 10 located therebtween. The upper contact 8 is a stationary contact suitably secured to a conductive rod, or stem 12, which at its upper end is united to the upper end cap 4. The lower contact 9 is a movable contact joined to a conductive operating rod, or stem 14, which is suitably mounted for movement. The operating rod 14 projects through an opening 16 in the lower end cap 5, and a flexible metallic bellows 18 provides a seal about the rod, or stem 14 to allow for movement of the rod without impairing the vacuum inside the envelope 2. As shown in FIG. 1, the bellows 18 is secured in sealing relationship at its respective opposite ends to the operating rod 14 and to the lower end cap 5.

Coupled to the lower end of the operating rod 14, suitable actuating means (not shown) is provided for driving the movable contact 9 upwardly into engagement with the stationary contact 8, so as to close the circuit through the interrupter 1. The closed position of the movable contact is indicated by the dotted lines 20. The actuating means is also capable of returning the contact 9 to its illustrated solid-line open position, so as to open the circuit through the interrupter 1. A circuit-opening operation will, for example, entail a typical gap length, when the contacts 8, 9 are fully separated, of perhaps ½ inch.

The arc, indicated at 24, that is established across the gap 10 between the electrodes 8, 9, as the electrodes are opened, and also when they are closed, vaporizes some of the contact material, and these vapors are dispersed from the arcing gap 10 toward the envelope 2. In the illustrated interrupter 1, the internal insulating surfaces 3*a* of the casing 3 are protected from the condensation of arc-generated metallic vapor and particles thereon by means of a tubular metallic shield 28 suitably supported upon the casing 3 and preferably isolated from both end caps 4 and 5. This shield 28 acts to intercept and to condense arc-generated metallic vapors before they can reach the casing 3. To reduce the chances for vapor bypassing the shield 28, a pair of end shields 30 and 32 are provided at opposite ends of the central shield 28.

With particular attention being directed to FIGS. 2, 3 and 4 of the drawings, it will be observed that there is provided an electrode structure 9 having no central electrode contact button, as used in previous designs of contact structure, such as set forth in Schneider U.S. Pat. No. 2,949,520. The contact surface 36 is in the form of a flat, segmented, annular ring, close to the outer periphery of the electrode, or contact 9. This contact surface 36 also serves the purpose of an arc-running surface during interruption.

As the contacts, 8, 9 are separated to interrupt a current, an arc 24 is established on the segmented electrode, or contact surfaces 36, which are essentially arc-horns; and the arc 24 is then driven in an azimuthal direction 40 (FIG. 2) around the contact surfaces 36. This is unlike the design of contact illustrated in Schneider U.S. Pat. No. 2,949,520, where the arc is established on a central contact button, and then spirals in combined radial and azimuthal directions to reach the outer periphery of the contact.

Initiation of the arc 24 in a location, as indicated by FIGS. 2-4, has the definite advantage over arc initiation on a centrally-located contact button. Arcs tend to "hang" up on central buttons, which produce a much less effective electromagnetic force tending to cause them to move. In the contact construction of the present invention, the spokes 44, extend slontingly or obliquely from the electrode stem 14 to the outer-disposed annular electrode conctact surfaces 36, which serve the function of current-carrying members.

Because the arc 24 is first established on the outer periphery 36 of the electrode structure 9, the proposed design has the advantage of having a lesser tendency, than previous designs, to drive the arc 24 radially outwardly toward the condensing shield 28. It has been found, from testing various electrode geometries, that arcs, which are blown too far outwardly in the radial direction, will attach to the condensing shield, and, as a result, may burn a hole in the condensing shield 28, and/or cause successive reignitions.

Schneider U.S. Pat. No. 2,949,520 has a radial component of electromagnetic force acting on the arc, thereby causing it to be forced radially outwardly. In addition, the metallic vapor, which is generated, at the contact button and on the spirals, as the arc moves outwardly, produces an aerodynamic force on the arc, which augments the electromagnetic force causing the arc to move radially outwardly.

There are at least two additional advantages stemming from the small amount of flexibility in the cantilevered contact members; (a) The small amount of flexibility aids in weld-breaking, and (b) The small amount of flexibility increases the total number of contact points, and, thereby, decreases the contact resistance.

It will be observed that the obliquely-extending spoke portions 44 support, in generally cantilever fashion, angularly-extending segments 36*a*, which are spaced from each other by a slot, designated by the reference numeral 37. As shown in FIG. 3, the slot 37 may vary from 0 degrees approximately 60 degrees. FIGS. 1, 2 and 4 illustrate a condition, where α is 0°, but, as shown in FIGS. 5-7, the slots 37 of the modified contact 38 may have an angular configuration, and this will assist in the arc-rotating movement.

It will be noted that the rod-shaped contact-support stems 12, 14 for the respective stationary and movable contacts have respective termination points 12*a*, 14*a* disposed in a plane Z—Z spaced axially inwardly from the support plane Y—Y, which is the plane of supporting attachment of the contact spokes 44. In other words, each obliquely-extending spoke 44 for each contact segment 36*a* supports the same rearwardly thereof in the support plane Y—Y.

Moreover, it will be observed that each spoke 44 supports its respective contact semgnet 36*a* at one end 36*b* thereof in a resulting generally L-shaped arrangement, as more clearly seen in FIGS. 2 and 8. Additionally, the spacing 46 between immediately-adjacent spokes 44 is relatively wide to result in an open, vented contact construction for readily venting rearwardly the ionized products of arcing to quickly get the same out of the arcing region 10.

The present invention has been described with particular application to electrical circuit-interrupting devices, that is to say to devices of the kind in which an electrical arc, drawn between two spaced electrodes or contacts disposed in an evacuated insulating enclosure, is to be interrupted, whereby to interrupt the flow of current in an electrical circuit in which the device is connected. However, the present invention also has application to other devices, which may be intended to serve as protective, or calibration spark-gap devices, the electrodes thereof being fixed, so as to enable arcing to occur between them, when the potential applied across them exceeds a predetermined value, or when "triggered." These devices are referred to in the art, as "vacuum spark gaps." Thus, although the present invention has been described in connection with the field of vacuumtype circuit interrupters, nevertheless the electrodes, or contacts proposed here for vacuum interrupters also find application in vacuum spark gaps, where the operating conditions are less difficult, because the electrodes never make physical contact with one another. However, the present invention is intended to cover both types of arcing devices.

From the foregoing description, it will be apparent that there has been provided novel separable contact structures for vacuum-type circuit interrupters, in which the arc is initially established at the outer-arc-running sruface **36,** and has generally an exclusive radial arc rotation movement **40.** Unlike previous designs, there is little radial outward movement against the condensing shield **28,** which otherwise would tend to burn a hole through the condensing shield **38.**

FIGS. **5, 6** and **7** illustrate a modified form of the invention in which the slots **37,** provided between adjacent segments **36***a* of the arc-running surface **36,** are angled, or slanting, as illustrated in FIG. **7** of the drawings. The angle α may vary from 0° to 600°. FIG. **3,** taken in conjunction with the contact structures of FIGS. **2** and **4,** illustrate a construction wherein α is 0°. FIG. **7** on the other hand, taken in conjunction with the contact structure **38** of FIGS. **5** and **6,** illustrate a slanting-slot configuration, in which α is approximately 60°. Of course, as well known by those skilled in the art, the angle α may vary, as desired. It is believed that the variance of α may assist in the rotational magnetic force exerted upon the arc **24.**

FIG. **8** illustrates still a further modification of the contact structure **39** of the instant application, in which a pair of arc-running surfaces **41, 42** are provided, both being of segmented construction. It will be observed that the spokes **44** each obliquely support a pair of segmented, radially-spaced, arc-running surfaces **41, 42,** which assist in arc interruption. Depending upon the magnitude of the current being interrupted, the arc may utilize one or the other of the arc-running surfaces **41, 42** or both. As before, the slots **37,** existing between adjacent segments, may vary in angular configuration. The angle α of the slot may have an angle of variation of from 0° to 60°.

Although there has been illustrated and described specific structures, it is to be clearly understood that the same were merely for the purpose of illustration, and that changes and modifications may readily be made therein by those skilled in the art, without departing from the spirit and scope of the invention.

I claim:

1. An alternating-current electric circuit interrupter of the vacuum-type comprising, in combination:

a. a first ring-shaped electrode having a segmented ring-shaped contact-engaging surface;

b. a second ring-shaped electrode having a segmented ring-shaped contact-engaging surface;

c. an evacuated envelope surrounding said first and second electrodes;

d. the two segmented ring-shaped contact-engaging surfaces of said first and second ring-shaped electrodes making abutting contacting engagement in the closed-circuit position of the vacuum-type circuit interrupter;

e. the arc during the opening operation of the interrupter being initially established between the separated ring-shaped segmented contact-engaging surfaces;

f. a rod-shaped contact-support stem (**12, 14**) for each segmented electrode having a termination point (**12***a*, **14***a*) disposed in a plane (Z—Z) spaced axially inwardly from the support plane (Y—Y) of the respective electrode;

g. an obliquely-extending spoke (**44**) for each contact segment (**36***a*) supporting the same rearwardly thereof in the support plane (Y—Y);

h. each spoke (**44**) supporting its respective contact segment (**36***a*) at one end thereof (**36***b*) in a generally L-shape;

i. the spacing between immediately-adjacent spokes (**44**) being relatively wide to result in an open, vented contact construction for readily venting rearwardly of ionized products of arcing for a consequent rapid build-up of dielectric strength;

j. the spokes for the first and second electrodes being mirror-images of each other to thereby cooperatively augment the arc-rotation movement of the established arc around the ring-shaped contact-engaging surfaces; and,

k. the axial distance between the supporting planes (Y—Y) of the first and second electrodes being sufficiently large to prevent substantial radial outward magnetic looping of the arc.

2. The alternating-current electric circuit-interrupter of claim **1,** wherein means provided within the evacuated envelope define a condensing shield about the electrodes.

3. The alternating-current electric circuit-interrupter of claim **1,** wherein the slots (**37**) between adjacent contact segments (**36***a*) are angularly disposed relative to the axial direction of the contact-support means (**12, 14**).

4. The combination according to claim **1,** wherein two segmented ring-shaped contact-engaging surfaces (**36, 42**) are provided.

5. The combination according to claim **4,** wherein the slots (**37**) of at least one of the two ring-shaped segmented contacting-engaging surfaces is angularly disposed relevant to the longitudinal direction of the contact-support stems (**12,14**).

6. The combination according to claim **5,** wherein both slots (**37**) of each of the two ring-shaped contact-engaging surfaces (**36, 42**) are angularly disposed relative to the longitudinal direction of the rod-shaped contact-support stems (**12, 14**).

7. The combination according to claim **1,** wherein the tip-portion (**36***c*) of each contact segment (**36**) overlaps the end-portion **36***b* of the adjoining contact segment.

8. The combination according to claim **1,** wherein each obliquely-extending spoke (**44**) for each contact segment (**36***a*) supports an additional inwardly-disposed contact segment (**42**).

* * * * *