April 29, 1969 J. W. ERICKSON 3,441,699

ARC CONTROL APPARATUS FOR LOAD-BREAK SWITCHES

Filed May 27, 1968 Sheet 1 of 2

FIG. 1

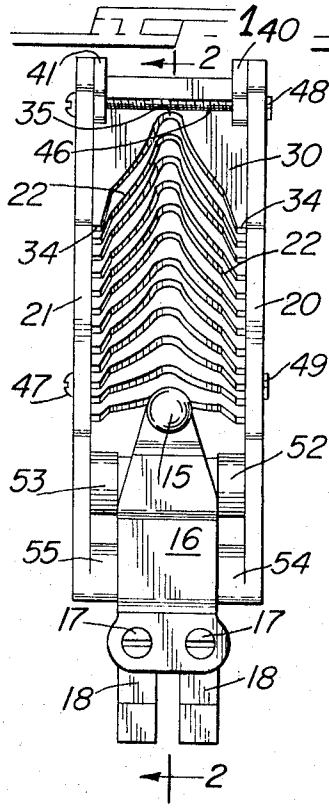


FIG. 4

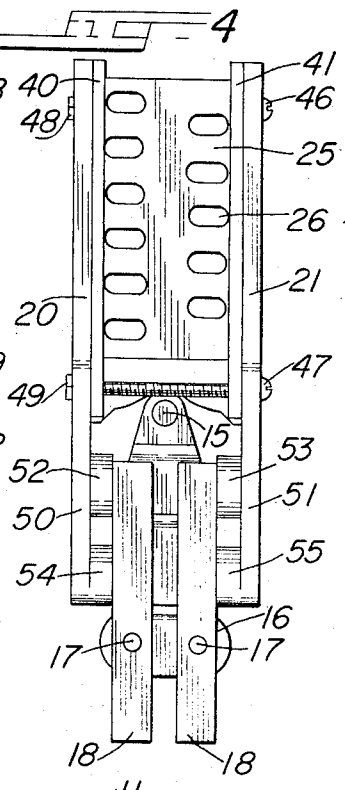
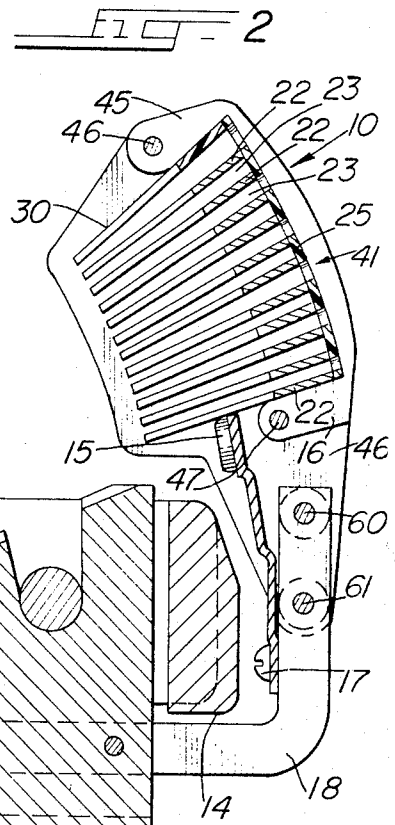


FIG. 2



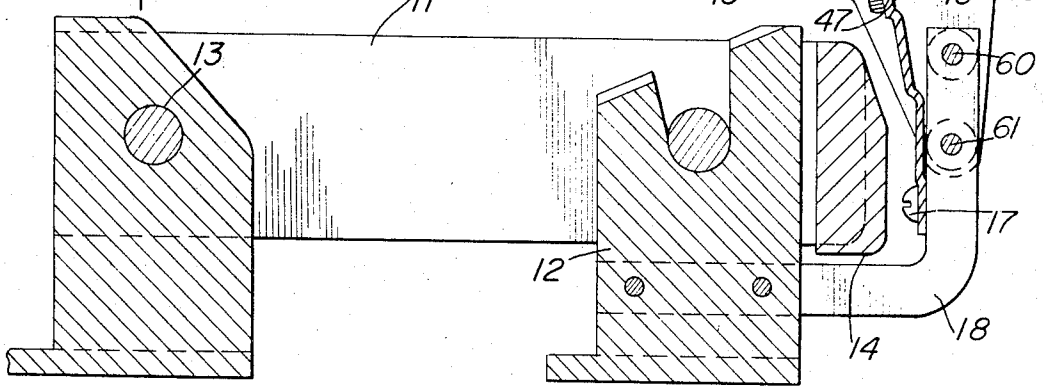
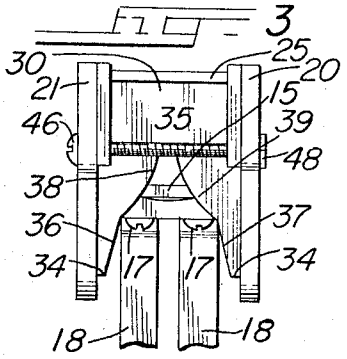


FIG. 3



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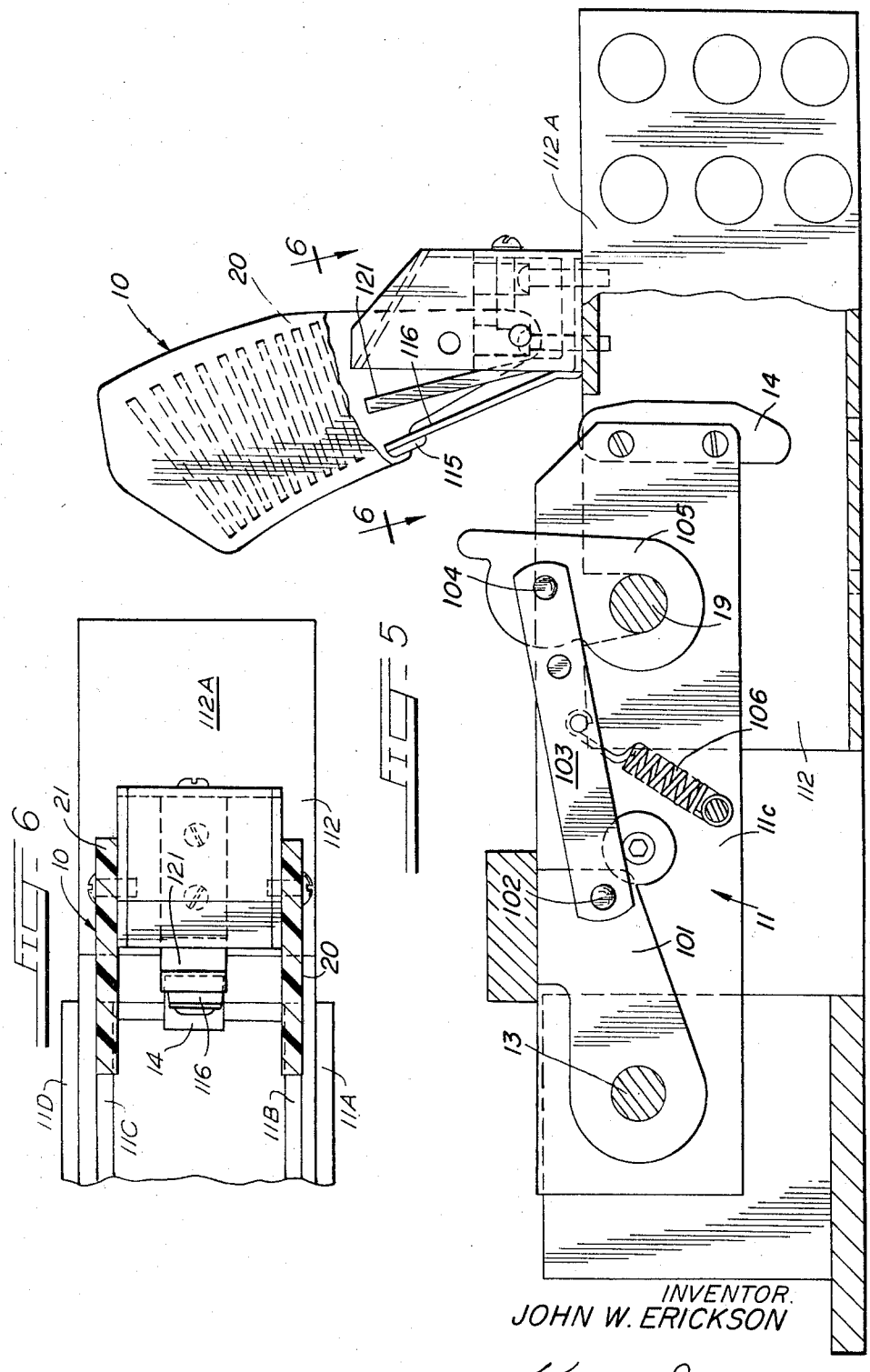
BY Wallace, Kinzer & Dorn

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ARC CONTROL APPARATUS FOR LOAD-BREAK SWITCHES

Filed May 27, 1968 Sheet 2 of 2



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3,441,699

ARC CONTROL APPARATUS FOR LOAD-BREAK SWITCHES

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Continuation-in-part of application Ser. No. 542,937, Apr. 15, 1966. This application May 27, 1968, Ser. No. 736,526

Int. Cl. H01h 9/38, 33/12, 33/18

U.S. Cl. 200—144 8 Claims

ABSTRACT OF THE DISCLOSURE

Arc control apparatus for a load-break switch having a movable contact that is movable along a given path into and out of engagement with a stationary contact; the arc control apparatus comprises an arc-quenching chute including a plurality of metal grid plates slotted to receive the movable contacts, the backs of the grid plates being closed by a back member formed of a material that releases a deionizing gas in the present of an arc, with apertures in the back member permitting escape of gases but precluding recombination of the arc behind the chute. An end grid plate of degassing material is also used. A separate arcing contact of spring construction backed up by a support member prevents arching between the main switch contacts.

Cross-references to related applications

This application is a continuation-in-part of application Ser. No. 542,937, filed Apr. 15, 1966, now abandoned.

Background of the invention

Load-break pressure contact switches for service entrance and like applications in which the switch may be opened or closed under fault conditions must withstand extremely high currents. Typical low voltage switches of this kind (usually 240 or 480 volts), although nominally rated for currents between 100 and 4000 amperes, may be required to withstand fault currents substantially in excess of 100,000 amperes. When a switch of this kind is actuated under fault conditions, an arc of extremely high current is established between the switch contacts. This frequently results in severe pitting of the switch contacts or even destruction of the switch. There is also a substantial possibility of fire or explosion if the arc is not extinguished almost immediately.

Conventional practice is to provide a multiple-chamber arc chute, along the path of movement of the movable switch contact, that separates the arc into segments and thus accelerate extinction of the arc. Some arc chutes of this kind include side wall members that generate a deionizing gas, in the presence of an arc, to assistant in extinction of the arc. Nevertheless, substantial difficulty is still encountered even where conventional arc chutes are employed, particularly in switches of higher amperage ratings.

It has also been known to provide arcing contacts, in switches of this kind, that are physically separate from, though electrically connected to the stationary contacts of the switch. A separate arcing contact aids materially in reducing pitting of the main switch contacts. Furthermore, in conventional bolted pressure contact switches, the use of a separate arcing contact eliminates the necessity for maintaining a dragging engagement between the movable and stationary contacts of the switch during intervals in which the switch is being opened or closed, so that the switch can be thrown more rapidly then would otherwise be possible. But a separate arcing contact can

also interfere with operation of the switch if firmly engaged with the movable switch contact during opening and closing movements. On the other hand, if loose engagement or even some separation is permitted, there may be excessive pitting or other damage to the arcing contact.

Summary of the invention

It is an object of the present invention, therefore, to provide a new and improved arc control apparatus for a load-break switch that comprises an arc-quenching chute of the multiple-chamber type affording improved efficiency in operation yet constructed of inexpensive materials and affording an economic assembly.

A more specific object of the invention is to provide a multichamber arc chute construction that allows dissipation of gases from the arc chute chambers while at the same time preventing recombination of the arc externally of the chute.

A further object of the invention is to provide an arc control apparatus that includes an arc chute that makes effective use of materials that produce deionizing gases during the arcing attendent upon opening and closing of a load-break switch under fault conditions, yet which maintains the strength and rigidity of metal construction.

An additional object of the invention is to provide a new and improved arc control apparatus for a load-break switch that comprises an arcing contact that is independent of the stationary contact of the switch and that is capable of diverting the arc produced on opening or closing of the switch from the stationary contact without engendering excessive pitting or potential damage to the arcing contact itself.

Accordingly, the invention relates to an arc control apparatus for a load-break switch employed in service entrance and like applications in which the switch may be opened or closed under fault conditions, the switch including a stationary contact and a movable contact that is movable along a given path into and out of engagement with the stationary contact. The arc control apparatus of the invention comprises a pair of opposed side frame members mounted in spaced relation to each other on opposite sides of the aforesaid path with a plurality of metal grid plates spanning the space between the frame members and forming a plurality of chambers subdividing the arc developed upon opening or closing of the switch. Each of these grid plates has a generally V-shaped opening in its forward edge through which the movable contact passes during its opening and closing movements. A back member, formed of a material that releases a deionizing gas in the presence of an arc, extends between the frame members behind the grid plates to close the back of each arc-dividing chamber. Preferably, this back member has a plurality of individual openings individually aligned with the arc dividing chambers but staggered from side-to-side of the assembly to allow release of gases from the chambers without permitting recombination of the arc. The apparatus further includes an end grid plate of substantially the same configuration as the metal grid plates and spanning the end of the frame members remote from the stationary contact of the switch, this plate also being formed of a material which releases a deionizing gas in the presence of an arc. An arcing contact, separate from the stationary contact, is located at the base end of the apparatus and constitutes a spring contact member backed up by a rigid support member with the contact member positioned to engage the end of the movable switch contact.

Other and further objects of the present invention will be apparent from the following description and claims and are illustrated in the accompanying drawings which, by way of illustration, shows preferred embodiments of

the present invention and the principles thereof and what is now considered to be the best mode contemplated for applying these principles. Other embodiments of the invention embodying the same or equivalent principles may be made as desired by those skilled in the art without departing from the present invention.

Brief description of the drawings

FIG. 1 is a front elevation view of an arc-quenching chute incorporated in an arc control apparatus constructed in accordance with one embodiment of the invention;

FIG. 2 is a sectional view, taken approximately along line 2—2 in FIG. 1, of one pole of a load-break switch equipped with arc control apparatus constructed in accordance with the invention;

FIG. 3 is a plan view of the arc-quenching chute of FIG. 1;

FIG. 4 is a rear elevation view of the arc-quenching chute of FIG. 1;

FIG. 5 is an elevation view of one pole of a load-break switch equipped with arc control apparatus constructed in accordance with another embodiment of the invention; and

FIG. 6 is a detail sectional view taken approximately along line 6—6 in FIG. 5.

Description of the preferred embodiments

FIGS. 1–4 illustrate an arc control apparatus for a load-break switch, including an arc-quenching chute **10**, constructed in accordance with one embodiment of the present invention. As shown in FIG. 2. the load-break switch includes a movable contact **11** formed by two blades, only one of the blades being illustrated in the drawing. In FIG. 2, the switch is shown in closed position, with the movable contact **11** engaging a fixed or stationary contact **12**. The movable contact **11** and stationary contact **12** may comprise elements of a load-break bolted-pressure switch of the kind described in U.S. Patent No. 3,213,247, with the two blades of the movable contact **11** being firmly bolted in pressure engagement with the stationary contact **12** by means of a clamping bolt **19** when the switch is closed. A more detailed explanation of a typical bolted pressure contact switch construction is provided hereinafter in connection with FIG. 5. It should be understood that the present invention is capable of use with many different electrical switch sizes and with a variety of different contact constructions and that the particular construction adopted for the switch or circuit breaker contacts is subject to substantial variation.

The movable switch contact **11** is pivotally mounted upon a pivot pin **13** for counterclockwise rotation from the closed position of FIG. 2 to an open position in which the movable contact is displaced from stationary contact **12**. Spanning the tip end of the movable contact **11**, between the two contact blades, is a contact block **14** which is a part of the movable contact structure. Contact block **14** is positioned for intermediate sliding engagement with a separate arcing contact **15** that is electrically connected to stationary contact **12**. When the switch is in fully closed or fully open positions, block **14** is free of arcing contact **15**; engagement therebetween occurs only during opening and closing movements of the switch. Arcing contact **15** is mounted upon a resilient conductive support member **16** secured by appropriate fasteners **17** to two conductive bars **18** which are in turn mounted on the stationary contact **12** of the switch.

From the foregoing, it will be seen that to open the illustrated pole of the switch, the blades of movable contact **11** are pivoted in a counterclockwise direction about pin **13**. During the early part of this pivotal movement, as the movable contact blades move forwardly along stationary contact **12**, contact block **14** engages arching contact **15**. Block **14** remains engaged with arcing contact **15** as the contact blades move free of the stationary contact of the switch. Thus, continuous electrical contact is maintained until the free end of the movable contact, block **14**, is well into the arc-quenching chute **10**. If the switch is operating properly and there is no fault in the electrical circuit connected to stationary contact **12**, only a relatively weak arc is drawn between contact block **14** and arcing contact **15** at the time block **14** moves free of the arcing contact and the switch is actually opened.

On the other hand, if there is a fault in the circuit controlled by the switch, it is possible that extremely high-current arc may be formed. The fault current may reach values well in excess of 100,000 amperes. Under these conditions, the separation of movable contact **11** from stationary contact **12**, and more particulary the subsequent separation of contact block **14** from arcing contact **15** results in an extremely high-current high-temperature arc between contact members **14** and **15**, within the arc-quenching chute **10**. The arc-quenching chute **10** must function to divide and extinguish this arc, preferably in less than one-half cycle, in order to avoid extreme damage to the switch and to prevent a possible fire or explosion.

The arc-quenching chute **10** includes a pair of opposed side frame members **20** and **21** of dielectric material disposed in spaced relation to each other on opposite sides of the arcuate path followed by the movable contact **11** during opening and closing operations of the switch. A plurality of metal grid plates **22** are mounted between frame members **20** and **21**. Grid plates **22** are usually made of steel, although other metals may be used if desired. Grid plates **22** are aligned in spaced relation to each other and form a series of slots or chambers **23** between adjacent grid plates. Thus, as the arc between contact block **14** and arcing contact **15** is drawn out with continuing movement of the movable contact of the switch, the arc is subdivided into a plurality of isolated portions.

The subdivided arc tends to expand through the chambers **23** and to recombine at the rear of the grid plates **22**, particlarly under high fault conditions. Recombination of the arc externally of the arc-quenching chute **10** is effectively prevented by a back plate **25** (see FIGS. 2 and 4) that is mounted between the side frame members **21** and **22** and that closes off the rear portion of each of the individual arc chambers **23**.

A completely solid and continuous back plate **25** creates a possibility and likelihood that, under fault conditions, the arc will be forced forwardly out of the chambers **23** and will be established between the movable switch contact comprising the blades **11** and the stationary contact **12**. This is prevented by providing back plate **25** with a plurality of individual openings **26**. Openings **26** permit part of the heat and gas created by the arc in the individual chambers **23** to pass through the back plate **25** and prevent the arc from being blown out frontwardly of the chambers **23**.

As shown in FIGS. 2 and 4, each of the apertures **26** in back plate **25** is aligned with a respective one of the chambers **23** and relieves pressure from that one chamber only. Furthermore, the individual apertures **26** are not as wide as the back portions of the related chambers **23** and do not permit the arc to blow completely out of the back portion of the arc-quenching chute. Instead, the apertures **26** are staggered from side-to-side of the chute **10** and each extends for less than one-half of the width of the back plate **25**. Thus, back plate **25** blocks the individual arc-quenching chambers on a staggered basis that prevents recombination of the arc segments in series behind the arc chute. With the illustrated construction adequate pressure relief is obtained without recombination of the arc behind the arc chute.

Back plate **25** and side plates **20** and **21** are each formed of a plastic, ceramic, hardboard, or even paperboard material which, when subject to high temperature, generate a deionizing gas that aids materially in extinc-

tion of the arc. A number of suitable and well-known refractories, plastics, and hardboard materials are commercially available that may be employed in the fabrication of the side frame members **20** and **21** and back member **25**. Preferably, side frame members **20** and **21** are made of a molded plastic material for economy and efficiency in production. The deionizing gases developed by the side plates **20** and **21** and the back plate **25**, particularly under the high temperatures developed in interruption of fault currents, aid materially in extinguishing the arc.

Another element in the arc-quenching chute **10** that aids materially in preventing continuation of the arc upon opening of the movable switch contact is the endmost grid plate **30**, FIGS. 1, 2 and 3. Grid plate **30** is not formed of metal. Instead, it is fabricated from a suitable plastic, ceramic, or hardboard material that generates deionizing gas when subject to the high temperatures of an electrical arc. Two or more of the end grid plates can be constructed of such material, but one is usually adequate.

As best seen in FIG. 1, the preferred configuration for the end plate **30** is one which is identical to the metal grid plates **22**. In the preferred construction, the metal grid plates **22** are stamped or punched from sheet steel. In a like manner, the end plates **30** may be punched to the same configuration from a sheet of plastic or hardboard material, using the same dies. Moreover, the thickness of the end grid plate **30** is preferably the same as the steel grid plates **22**.

As shown in FIGS. 1 and 3, grid plates **22** and **30** are relatively flat plates each formed with a V-shaped opening of decreasing size from their forward edges **34** toward a rear central surface **35**. More particularly, the openings in the grid plates **22** and **30** each comprise a pair of converging oblique edges **36** and **37** leading to rounded surfaces **38** and **39** terminating in the rounded surface **35**. The shape of the openings in each of the grid plates **22** and **30** is dimensioned to surround the tip portion of the movable switch contact, comprising block **14**, on three sides without contacting the block, thereby providing a wraparound arc chute for the switch. As seen in FIG. 2, grid plates **22** and **30** are arranged in an arcuate configuration along radial lines from the pivotal axis of the movable switch contact (pivot pin **13**) to surround the outer ends of the movable switch contact **11** as the latter moves along its arcuate path in opening or closing of the switch. This construction assures isolation of the arc, upon actuation of the switch, within the chambers **23** where it is divided and extinguished.

For convenience of assembly, side frame members **20** and **21** are each provided with a series of slots or openings for receiving the end portions of the side walls of the grid plates **22** and **30** to hold the grid plates in their mounted position between the side frame members of the arc-quenching chute. Back plate **20** is held in position against the rearward portions of the grid plates by two generally U-shaped shoulder or mounting members **40** and **41** that are a part of the side frame members **20** and **21**, respectively. Thus, each mounting member has an upper generally right-angle leg **45** extending over the top grid plate **30** and a lower leg **46** extending beneath the lower grid plate **22**. Mounting members **40** and **41** are shown as separate elements in the drawing but may be formed integrally with the respective side frame members **20** and **21**.

Grid plates **22** and **30** and back plate **25** are all locked into the assembly comprising arc-quenching chute **10** by means of a pair of tie members **46** and **47** that extend between the side frame members **20** and **21** of the chute. Nuts **48** and **49** threaded onto the tie members hold the complete assembly together in rigid relationship. Manifestly, other kinds of mounting or securing means can be employed in lieu of bolts **46** and **47**. For example, grid plates **22** may themselves include fasteners extending through the opposed side frame members **20** and **21** and crimped to provide a rigid assembly. The illustrated construction is preferred, however, since it avoids any necessity for individual fastening of the grid plates to the side frame members.

Arc chute **10** can be mounted independently of the electrical portion of the switch. However, in the preferred construction illustrated in FIGS. 1–4, the arc chute is directly mounted upon a part of the stationary contact for the switch. More specifically, the side frame members **20** and **21** include dependent fingers **50** and **51** formed with opposed pairs of integral bosses extending toward one another. An upper pair of bosses **52** and **53** and a lower pair of bosses **54** and **55** on the side frame members receive bolts **60** and **61**, respectively, to mount the arc-quenching device on the spaced bars **18** that support the arcing contact **15** and that constitute a part of the stationary contact of the switch.

With electrical switches of different ratings, the size and shape of grid plates **22** and **30** may be changed. However, the side frame members **20** and **21** may be utilized for a relatively large range of switch ratings without modification. More specifically, side frame members **20** and **21** of a given specific size may be readily employed with switches encompassing a wide range of voltage and current ratings (e.g., 120 to 480 volts and 100 to 1200 amperes) merely by changing the size of the grid plates.

FIGS. 5 and 6 illustrate a single pole of a load-break switch that incorporates a modification of the arc control apparatus of the present invention. The movable contact **11** of the switch comprises two pairs of movable contact blades; only one blade appears in FIG. 5 but segments of each are illustrated in FIG. 6, being designated as blades **11A**, **11B**, **11C** and **11D**. As before, the movable blade contact is pivotally mounted upon the pivot pin **13**. FIG. 5 illustrates a part of the operating mechanism for the switch, typical of construction used in bolted pressure contact switches.

The operating mechanism of the switch as shown in FIG. 5 comprises a crank **101** that is pivotally mounted upon pin **13**, rotation of crank **101** being independent of pivotal movement of the blades **11A–11D** forming the movable contact **11** of the switch. Crank **101** is pivotally connected by a pin **102** to a link **103** with the opposite end of link **103** being pivotally connected by a pin **104** to a lever **105**. The lever **105** is affixed to the bolt **19** that extends across the movable contact **11** of the switch between the two pairs of contact blades. Bolt **19** is threaded into two nuts (not shown) that are affixed to the outside blades of the movable contact assembly. A spring **106** is connected between link **103** and the inner contact blades.

In the construction illustrated in FIGS. 5 and 6 the arc-quenching chute **10** is utilized without substantial change from the embodiment described above. It includes the side frame members **20** and **21** mounted upon an extension portion **112A** of the stationary contact **112**, which in this instance is of hollow squared-cylinder construction. Inasmuch as the arc-quenching chute is the same as described above in connection with FIGS. 1–4, it is not shown in detail in FIGS. 5 and 6.

The embodiment of FIGS. 5 and 6 further includes an arcing contact **115** mounted upon a resilient conductive arm **116** that is affixed to the stationary contact extension **112A**. As before, the arcing contact is positioned to engage a contact block **14** mounted between the tip ends of the movable blades of contact **11**. In this instance, however, the arcing contact is provided with a rigid support member **121** mounted behind the arcing contact in position to limit movement of the arcing contact away from the movable contact of the switch.

In opening of the switch, crank **101** is rotated in a clockwise direction about pin **13**. The initial movement of the crank pulls link **103** to the left and pivots lever **105**

in a counterclockwise direction. This rotates bolt **19** and releases the clamping pressure that presses the two pairs of movable contact blades against the legs of the stationary contact **112** when the switch is closed. Continuing movement of crank **101**, after unbolting of the switch, pivots movable contact **11** in a counterclockwise direction about pivot pin **13** to open the switch in the manner described above in relation to the embodiment of FIGS. 1–4.

During opening and closing movements of the switch it is quite important that little or no mechanical drag be applied to the contacts. As the switch opens, contact block **14** on the movable cointact engages arcing contact **115**. The relatively light pressure exerted by the spring arm **116** upon which the arcing contact is mounted does not interfere to any appreciable extent with the opening and closing movements of the switch. This makes it possible to open and close the switch rapidly, minimizing arcing within the switch and reducing pitting of all contacts including the arcing contact.

If the switch is opened or closed under fault conditions, the high current arc produced between contact block **14** and arcing contact **115** forcibly drives the arcing contact away from block **14**. With a spring **116** that is light enough to permit rapid actuation of the switch, as described above, the force applied to the arcing contact may be great enough to deform the arcing contact mount or even break it off completely. The result may be permanent damage to the stationary contact **112** through excessive arcing between the main contacts of the switch, since the arcing contact **115** is no longer availavle for protection. Thus, it may become necessary to replace the arcing contact and the switch operator may not immediately recognize this requirement.

This difficulty is obviated by the use of the support **121** mounted close behind arcing contact **115**. The relatively heavy and rigid support **121** interrupts the backward movement of arcing contact **115**, under fault conditions, before the arcing contact can move far enough to effect a permanent deformation of its spring **116**. Consequently, a relatively lightweight spring **116** can be used safely without substantial likelihood of damage to the arcing contact or any other portion of the switch as the result of opening or closing of the switch under fault conditions, while at the same time avoiding excessive drag on the switch for normal opening and closing movements. The illustrated construction provides much freer movement of the switch than is possible with more conventional arrangements in which arcing contacts are engaged by pressure between the switch blades in a manner similar to that utilized in conjunction with the prinicpal stationary contact of the switch.

Hence, while preferred embodiments of the invention have been described and illustrated, it is to be understood that they are capable of variation and modification.

I claim:

1. In a load-break switch for service entrance and like applications in which the switch may be opened or closed under fault conditions, said switch including a stationary contact and a movable contact, said movable contact being movable along a given path into and out of engagement with said stationary contact to open and close the switch, arc control apparatus comprising:

a pair of opposed side frame members disposed in spaced relation to each other on opposite sides of said path;

a plurality of metal grid plates spanning the space between said frame members to form a plurality of chambers subdividing the arc developed upon opening or closing of the switch,

each of said grid plates having a generally V-shaped opening in its forward edge through which said movable contact passes during its opening and closing movements;

a back member extending between said frame members and disposed rearwardly of said grid plates to close the back of each of said chambers, said back member being formed of a material which releases a deionizing gas in the presence of an arc;

and an end grid plate of substantially the same configuration as said metal grid plates, spinning the end of said frame members remote from said stationary contact, formed of a material which releases a deionizing gas in the presence of an arc.

2. Arc control apparatus for a load-break switch according to claim **1** in which said back member has a plurality of individual openings extending therethrough, each opening being aligned with a respective one of said chambers, said openings each extending for less than one-half the width of its associated chamber and said openings being staggered alternately from side-to-side of said apparatus to allow dissipation of heat and gas from the chambers without recombination of the arc externally of the chambers.

3. Arc control apparatus for a load-break switch according to claim **1** in which said side frame members each includes a plurality of slots for receiving and aligning said grid plates in an arcuate array, said apparatus further including at least two tie members extending across said device between said side frame members for securing said side frame members, said back member, and said grid plates together in a rigid assembly.

4. Arc control apparatus for a load-break switch according to claim **3** and further including a pair of mounting members, one of said mounting members extending along each of said side frame members in engagement with the edge portion of said back member to clamp said back member between said mounting members and said grid plates.

5. Arc control apparatus for a load-break switch according to claim **1** in which said grid plates are aligned in an arcuate array and are disposed along radial lines from the pivot point of an arcuately movable switch contact with the forward edges of the grid plates spaced more closely adjacent to one another than the rearward ends of the grid plates and in which said openings in said forward edges of said grid plates define a convergent arcuate passageway for said movable contact.

6. Arc control apparatus for a load-break switch according to claim **1** and further including a resilient arcing contact electrically connected to but spaced from the stationary contact of said switch, located along the path of said movable switch contact in position to engage the end portion of said movable contact with only a light pressure over a portion of said path that overlaps the separation of the movable contact from said stationary contact on opening of the switch.

7. Arc control apparatus for a load-break switch according to claim **6** in which said arcing contact is a cantilever spring supported contact positioned adjacent one end of said movable contact and further comprising an auxiliary support member mounted adjacent said arcing contact on the opposite side thereof from said movable contact in position to limit movement of said arcing contact away from said movable switch contact in the presence of high fault currents.

8. In a load-break switch for service entrance and like applications in which the switch may be opened or closed under fault conditions, said switch including a stationary contact and a movable contact, said movable contact being movable along a given path into and out of engagement with said stationary contact to open and close the switch, arc control apparatus comprising:

an arc-quencing chute, mounted in substantially encompassing relation to said path adjacent said stationary contact, for subdividing and extinguishing the arc developed upon opening or closing of the switch;

a resilient cantilever-mounted arcing contact, electrical-

ly connected to said stationary contact, positioned to engage the end portion of said movable contact, with only a light pressure, during a part of the movement of said movable contact along said path;

and a rigid auxiliary support member positioned in close spaced relation to said arcing contact on the side thereof opposite said movable contact, for limiting movement of said arcing contact away from said movable contact in the presence of high fault currents.

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ROBERT S. MACON, *Primary Examiner.*

U.S. Cl. X.R.

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