United States Patent

Erickson

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[45] **Aug. 1, 1972**

[54] **ARC CONTROL FOR LOAD-BREAK SWITCHES**

[72] Inventor: **John W. Erickson,** Crystal Lake, Ill.

[73] Assignee: **Erickson Electrical Equipment Co.,** Chicago, Ill.

[22] Filed: **Nov. 2, 1970**

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[52] **U.S. Cl.** .....**200/144 R,** 200/146 R

[51] **Int. Cl.**.....**H01h 33/08,** H01h 33/12

[58] **Field of Search**.....200/147, 144, 146

[56] **References Cited**

UNITED STATES PATENTS

3,071,666	1/1963	Ellsworth et al.	200/147 X
3,441,699	4/1969	Erickson	200/144
3,496,319	2/1970	Norden	200/146

FOREIGN PATENTS OR APPLICATIONS

1,240,973	5/1967	Germany	200/146
1,300,411	6/1962	France	200/146

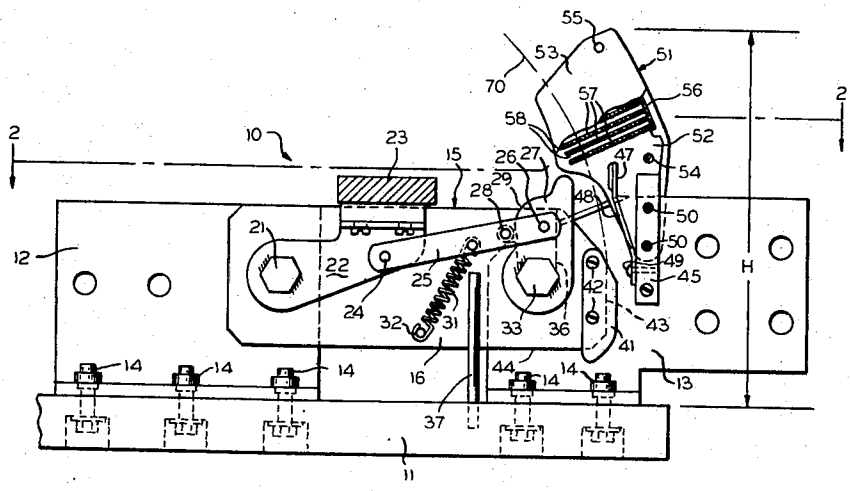
Primary Examiner—Robert S. Macon

Attorney—Kinzer, Dorn & Zickert

[57] **ABSTRACT**

A high-current load-break switch for applications in which the switch may be opened under fault conditions, comprising a dual-blade movable contact pivoted on one fixed contact and engageable with a second fixed contact, arcing contacts asymmetrically mounted on one blade of the movable contact and on the second fixed contact, and an asymmetrical arc chute aligned with the arcing contacts.

3 Claims, 4 Drawing Figures



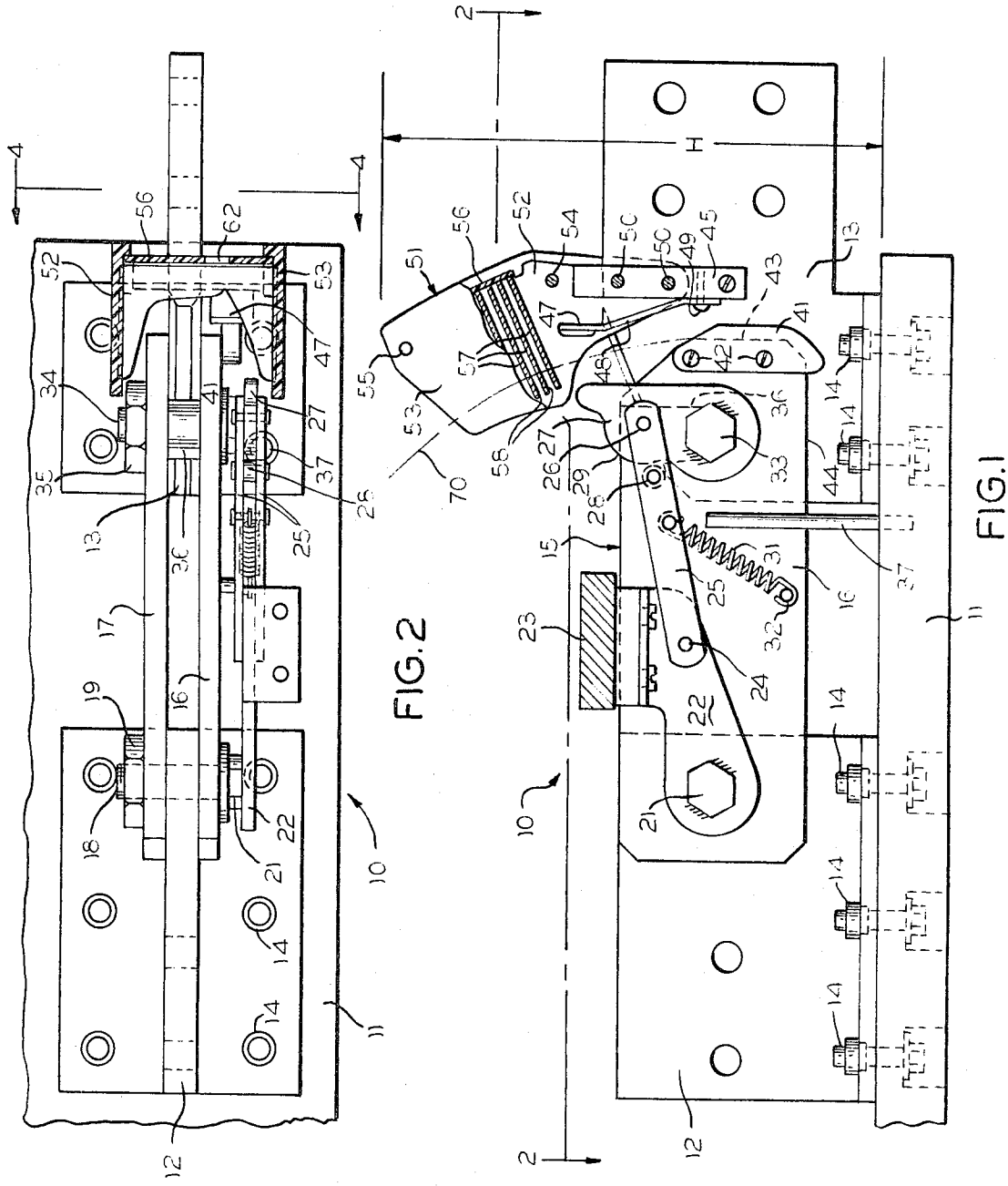


FIG. 1

FIG. 2

INVENTOR
JOHN W. ERICKSON

BY
Kinzer, Dorn & Zickert
ATTORNEYS

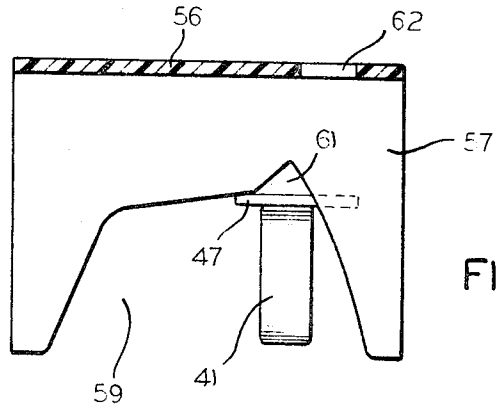


FIG.3

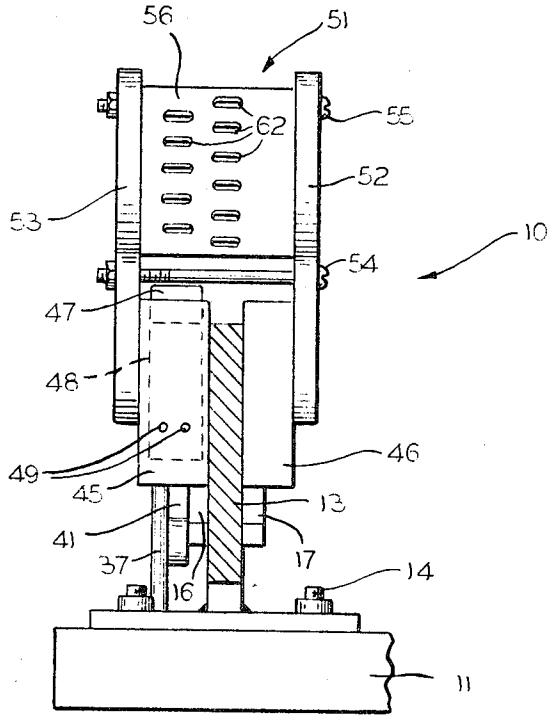


FIG.4

INVENTOR
JOHN W. ERICKSON

BY
Kinzer, Dorn & Zickert
ATTORNEYS

ARC CONTROL FOR LOAD-BREAK SWITCHES

BACKGROUND OF THE INVENTION

There are numerous applications, as in service entrance switches and similar installations, in which a switch may be required to open or close under fault conditions, and hence must withstand extremely high currents. Thus, many low voltage switches rated for currents between 1,000 and 5,000 amperes may be required to withstand fault currents exceeding 100,000 amperes. When such a switch is opened or closed with a fault in the system, extreme high-current arcing occurs between the switch contacts, which may result in severe pitting of the contacts. There is often a substantial possibility of fire or explosion unless the arc is extinguished almost immediately.

A highly effective arc control apparatus for such load break switches is disclosed and claimed in Erickson U.S. Pat. No. 3,441,699, issued Apr. 29, 1969. The arc control apparatus of the Erickson patent provides an improved multiple-chamber arc chute that subdivides the arc, and that effectively dissipates the heat and the gases generated by the arc without permitting the arc to recombine outside of the chute. That apparatus also includes a resilient stationary arcing contact that is limited in its movements to afford optimum speed in arc separation without undue interference with the normal operation of the switch.

In many load break switches in which a dual-blade movable contact is employed, it is desirable to extend the secondary contact beyond the movable contact to afford a straight-line connection for the switch contacts. With conventional construction, in which the arcing contacts are symmetrically located relative to the main switch contacts, this necessitates mounting of the arcing contacts and the arc chute entirely above the secondary fixed contact. A construction of this kind makes it difficult to achieve adequate arc separation and also increases the physical dimensions of the switch. On the other hand, asymmetrical constructions have not been considered effective, and have created substantial difficulties in the design and construction of the arc control apparatus, particularly the arc chutes.

SUMMARY OF THE INVENTION

It is a principal object of the invention, therefore, to provide a new and improved arc control apparatus particularly suitable for use in high-current load break switches, particularly switches capable of normal operation at currents in excess of 1,000 amperes and subject to opening or closing under fault conditions.

A specific object of the invention is to provide an improved, highly compact asymmetrical arc control apparatus for a load break switch in which the secondary fixed contact of the switch is extended directly beyond the point of engagement with the movable switch contact.

An additional object of the invention is to provide a new and improved arc chute construction that efficiently and effectively suppresses a high-current arc generated between arcing contacts that are asymmetrically located with respect to the main contacts of a switch.

Accordingly, the invention relates to a load break switch for service entrance and like applications in which the switch may be opened or closed under fault conditions. The switch comprises a first fixed contact and a second fixed contact mounted on a base in spaced relation to each other. The switch further includes a movable contact, comprising two parallel blades each having one end pivotally mounted on the first fixed contact, that is movable along a given path between an open position displaced from the second movable contact and a closed position in which the free ends of the blades engage substantial areas of the opposed sides of the second fixed contact. A first arcing contact is mounted on the outer side of the tip of one movable contact blade. A second arcing contact is mounted at one side of the aforesaid path adjacent to and electrically connected to the second fixed contact; the second arcing contact is aligned with the first arcing contact, and engages the first arcing contact during opening and closing of the switch. An arc chute is included in the switch and comprises a frame encompassing three sides of the switch blade path immediately adjacent the secondary arcing contact. A plurality of grid plates are mounted in this frame, forming a plurality of arc-dividing chambers. Each grid plate has an asymmetrical opening in its forward edge to permit passage of the tips of the movable contact blades through the arc chute and each grid plate opening includes a notch extension that is aligned with the arcing contact mounted on the movable contact.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevation view of a load break switch constructed in accordance with one embodiment of the invention, with some parts of the switch cut away to reveal internal construction;

FIG. 2 is a plan view of the switch, partly in cross section, taken approximately on line 2—2 of FIG. 1;

FIG. 3 is a detail plan view of a single grid plate from the arc chute of the switch, together with associated components of the switch; and

FIG. 4 is an end elevation view taken approximately as indicated by line 4—4 of FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The load break switch **10** illustrated in the drawings, and particularly in FIGS. **1**, **2** and **4**, which comprises a preferred embodiment of the present invention, includes an insulator base **11** upon which a first fixed contact **12** and a second fixed contact **13** are mounted in spaced relation to each other. Fixed contacts **12** and **13** are secured to base **11** by appropriate means such as the bolts **14**. Switch **10**, as illustrated, is a single throw switch; it should be recognized, however, that the switch may comprise one pole of a two, three, or other multi-pole switch assembly.

A movable contact **15** comprising two parallel blades **16** and **17** is pivotally mounted upon the first fixed contact **12**. The pivotal mounting for movable contact **15** comprises a shaft **18** that extends through one end of each of the two blades **16**, **17** and through the fixed contact **12**. One end of shaft **18** is threaded into a clamp nut **19** affixed to blade **17**. The other end of the shaft is formed as a hexagonal bolt head **21** that is welded or otherwise secured to an operating lever **22**. Operating lever **22** may be connected to an actuating bar **23** (FIG. **1**) that is a part of a manual or motorized switch operating mechanism (not shown).

Operating lever 22 is also pivotally connected by a pin 24 to a dual toggle link 25. The other end of link 25 is pivotally connected by a pin 26 to a clamp lever 27. A cam follower surface 28 mounted upon link 25 engages a cam surface 29 on a clamp lever 27. A toggle spring 31 is connected from the center of link 25 to a pin 32 mounted upon contact blade 16.

Clamp lever 27 is affixed to a hexagonal head 33 on one end of a clamp shaft 34 that extends between contact blades 16 and 17; the other end of clamp shaft 34 is threaded into a clamp nut 35 mounted on the external surface of blade 17. When the switch blade 15 is closed, as shown in FIGS. 1 and 2, shaft 34 extends through a slot 36 in the front end of fixed contact 13. A toggle break post 37 is mounted adjacent the front edge of contact 13, in alignment with link 25, as best shown in FIGS. 1 and 2.

A first arcing contact 41 is affixed to the outside edge of the tip portion of movable contact blade 15. The arcing contact 41 may be mounted on blade 16 by appropriate means such as the screws 42 (FIG. 1) and extends beyond the free end 43 of the movable contact blade. Preferably, a part of the arcing contact 41 also extends below the lower edge 44 of blade 16.

As shown in FIG. 4, two metal blocks 45 and 46 are mounted on the opposite sides of second fixed contact 13. The two blocks 45 and 46 are aligned with each other and are spaced a short distance from the free end 43 of the movable switch contact, as shown in FIG. 1. A second arcing contact 47 is mounted upon one end of a conductive spring 48, the other end of spring 48 being mounted on block 45 by screws 49. Arcing contact 47 is positioned to engage contact 41 during opening and closing of switch 10, as described more fully hereinafter.

An arc chute 51 is mounted upon blocks 45 and 46. Arc chute 51 comprises two side frame members 52 and 53, formed of a plastic, ceramic, hardboard, or other material which, when subject to high temperature, generates a deionizing gas that aids materially in extinction of the arc. A number of materials of this kind are well known and commercially available. Preferably, the side frame members 52 and 53 are fabricated as molded plastic members for economy and efficiency in production.

The lower portions of the two side frame members 52 and 53 are secured to the metal blocks 45 and 46 by screws 50. The upper portions of frame members 52 and 53 are connected to each other by a pair of elongated bolts 54 and 55. A back frame member 56 is mounted between frame members 52 and 53, and closes off the back of the arc chute. Back member 56, like the side frame members 52 and 53, should be formed of a material that generates a deionizing gas when subjected to the high temperature of an electrical arc.

A plurality of metal grid plates 57 are mounted between the side frame members 52 and 53, spanning the space between the frame members to form a plurality of individual arc-dividing chambers 58 (FIG. 1). Each grid plate 57, as shown in the detail view of FIG. 3, is provided with an opening 59 at its forward edge. Opening 59 is not symmetrical in configuration; moreover, opening 59 is formed with a notch extension 61 that is aligned with the movable arcing contact 41. The openings 59 in plates 57 permit the leading edges of the movable contact blades 16 and 17 and the arcing contact 41 to move through arc chute 51 in close proximity to the plates so that the arc drawn between contacts 41 and 47, when those contacts separate, is effectively divided at a plurality of points. This construction assures effective isolation of the arc within the chambers 58, where it is rapidly extinguished.

Back member 56 is provided with a plurality of individual apertures 62, one aperture 62 being aligned with each of the chambers 58 in arc chute 51. Apertures 62 are located at the side of back member 56 adjacent the notches 61 in the grid plates, and hence are generally aligned with arcing contacts 41 and 47. Apertures 62 allow the hot gases to escape from the arc chute chambers, but prevent recombination of the arc externally of the arc chute.

In considering operation of switch 10, it may be assumed that the switch starts in the fully closed position illustrated in the drawings. In this position, shafts 18 and 34 have been tightened in their respective clamp nuts 19 and 35, maintaining firm broad-area engagement between the blades 16 and 17 of movable contact 15 and the opposite sides of both of the fixed contacts 12 and 13. Toggle spring 31, by its connection to link 25, serves to maintain the switch blade in this clamped closed position.

To open switch 10, bar 23 is moved by an external operating mechanism (not shown) to initiate counterclockwise rotation of operating lever 22. As lever 22 starts to turn, it effects a corresponding counterclockwise rotation of shaft 18, releasing the clamping pressure that has held blades 16 and 17 against the sides of the first fixed contact 12. Moreover, the counterclockwise movement of operating lever 22 pulls link 25 to the left, as seen in FIG. 1, pivoting clamp lever 27 counterclockwise. This rotates clamping shaft 34 in a counterclockwise direction and releases the clamping pressure between the blades of movable contact 15 and the second fixed contact 13.

With continued rotation of operating lever 22, the two pivotal connecting pins 24 and 26 are ultimately brought into alignment with the axis of shaft 35, locking levers 22 and 27 and link 25 in a fixed toggle position. Thereafter, further counterclockwise movement of operating lever 22 results in a corresponding counterclockwise rotation of contact 15, moving the free end of the contact blades 16 and 17 along an arcuate path indicated by the phantom line 70. It should be noted that the portion of the path 70 immediately adjacent to the second arcing contact 47 is encompassed on three sides by arc chute 51.

As the movable contact 15 moves upwardly along path 70, it approaches a point at which the movable contact is disengaged from fixed contact 13. Before disengagement takes place, arcing contact 41 engages arcing contact 47 and these two arcing contact 47 and these two arcing contacts remain in engagement until movable contact 15 clears fixed contact 13. Subsequently, continued movement of contact 15 along path 70 causes arcing contact 41 to move beyond contact 47, the movable contact continuing to a full open position substantially separated from both arcing contact 47 and fixed contact 13.

As arcing contacts 41 and 47 begin to separate, a substantial arc is drawn between the two contacts. If

there is a fault somewhere in the electrical circuit connected to fixed contact **13**, an extremely high current arc may be produced, of the order of 100,00 amperes and more. In more normal operation, with no fault present, the arc current may be of the order of several hundred to several thousand amperes, depending upon the circuit parameters. In either instance, the arc is subdivided a number of times into chambers **58** between plates **57**. The heat and gases generated by the arc can escape through the limiting openings **62** in the back frame member **56**, but the staggered arrangement of aperture **62** effectively precludes recombination of the arc externally of arc chute **51**. Location of aperture **62** in substantial alignment with arcing contact **41** assures rapid and efficient cooling of the arc and permits extinguishing the arc in a very short time.

On closing of the switch, the actions described above are essentially reversed, except that less arcing occurs. As movable contact **15** moves downwardly along path **70**, and contact **41** approaches contact **47**, an initial arc is established. Under ordinary conditions this is extinguished almost immediately when the contacts engage each other. Continued downward movement of contact **15** brings link **25** into engagement with post **37**, breaking the toggle connection. This action takes place as contact **15** reaches the position shown in FIG. **1**, after which continued clockwise movement of operating lever **22** drives the clamp mechanisms to the positions shown, clamping each of the movable blades **16** and **17** firmly to both fixed contacts **12** and **13**.

The eccentric construction employed for arcing contacts **41** and **47**, in conjunction with the asymmetrical configuration of arc chute **51**, and particularly grid plates **57**, makes it possible to extend contact **13** to any desired length while at the same time maintaining a minimal overall height H for the switch **10**. Height H is further minimized by the extension of arcing contact **41** below blade **16**, allowing a low profile for arcing contact **47**. The reduced depth of the arc dividing chambers **58**, at the grid plate notches **61**, does not impair the effectiveness of arc chute **51**; on the contrary, the arc chute is as effective as in previously known constructions. Location of apertures **62** adjacent notches **61** aids in rapid cooling and extinction of the arc, but does not allow recombination of the arc outside the arc chute.

I claim:

1. A load break switch for service entrance and like applications in which the switch may be opened or closed under fault conditions, comprising:

a first fixed contact and a second fixed contact mounted on a base in spaced relation to each other;

a movable contact, comprising two parallel blades each having one end pivotally mounted on said first fixed contact and movable along a given path between an open position displaced from said second movable contact and a closed position in which inner surfaces of the other ends of the blades engage substantial areas of the opposed sides of said second fixed contact;

a first arcing contact mounted on the outer side surface of one blade of said movable contact;

a second arcing contact, fixedly mounted at one side of said path, adjacent to but spaced from and electrically connected to said second fixed contact, said second arcing contact being aligned with said first arcing contact and engageable therewith during opening and closing movements of said movable contact;

an arc chute comprising:

a frame, formed of a material which releases a deionizing gas in the presence of an arc, encompassing three sides of said path immediately adjacent said second arcing contact, said frame projecting beyond said path, on said one side, to a greater width than said arcing contacts,

a plurality of grid plates, mounted in and extending across said frame and forming a plurality of arc-dividing chambers each extending across the entire width of said path,

each grid plate having an asymmetrical opening in its forward edge to permit passage of the ends of said movable contact blades therethrough, each said opening including a notch extension, at said one side of said path, aligned with said arcing contacts.

2. A load break switch according to claim **1** in which said first arcing contact extends below the bottom edge of said one blade and said second arcing contact is positioned immediately adjacent the top edge of said second fixed contact, with said arc chute frame extending downwardly along the sides of said second fixed contact to afford a switch structure of minimum overall height.

3. A load break switch according to claim **1** in which the back of said frame includes a plurality of individual apertures one for each arc-dividing chamber, to allow dissipation of gas and heat from said chambers, said apertures being located in approximate alignment with said notches in said grid plates.

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