US Patent & Trademark Office
Patent Public Search | Text View

United States Patent Application Publication 20250259805
Kind Code A1
Publication Date August 14, 2025
Inventor(s) Jur; Arthur James et al.

SECONDARY ARCING CONTACT FOR AN ELECTRICAL SWITCH

Abstract

A switch includes: a first stationary electrical contact; a second stationary electrical contact; a movable electrical contact assembly attached to the second stationary electrical contact and configured to separate from the first stationary electrical contact to open the switch; a first arcing contact on the movable electrical contact assembly; a second arcing contact on the first stationary electrical contact; and a secondary arcing contact electrically connected to the movable electrical contact assembly. The secondary arcing contact is connected to the second arcing contact when the switch is closed and remains connected to the second arcing contact during at least part of an opening operation of the switch.

Inventors: **Jur; Arthur James (Cleveland, TN), Rao; Abhishek (Pune, IN), Pandey; Durgesh Kumar (Gonda, IN)**

Applicant: **Eaton Intelligent Power Limited** (Dublin, IE)

Family ID: **1000007740281**

Appl. No.: **18/441671**

Filed: **February 14, 2024**

Publication Classification

Int. Cl.: **H01H9/38** (20060101)

U.S. Cl.:

CPC **H01H9/38** (20130101);

Background/Summary

TECHNICAL FIELD

[0001] This disclosure relates to a secondary arcing contact for an electrical switch.

BACKGROUND

[0002] An electrical switch includes stationary electrical contacts and a movable electrical contact. The state of the electrical switch is changed from ON to OFF and OFF to ON by moving the movable electrical contact relative to the stationary electrical contacts. The stationary electrical contacts may be enclosed in a housing.

SUMMARY

[0003] In one aspect, a switch includes: a first stationary electrical contact; a second stationary electrical contact; a movable electrical contact assembly attached to the second stationary electrical contact and configured to separate from the first stationary electrical contact to open the switch; a first arcing contact on the movable electrical contact assembly; a second arcing contact on the first stationary electrical contact; and a secondary arcing contact electrically connected to the movable electrical contact assembly. The secondary arcing contact is connected to the second arcing contact when the switch is closed and remains connected to the second arcing contact during at least part of an opening operation of the switch.

[0004] Implementations may include one or more of the following features.

[0005] The secondary arcing contact may be attached to the movable electrical contact assembly with an elastic connection that is configured to apply a force to the secondary arcing contact. The force may be greatest when the switch is closed. The secondary arcing contact may extend from a first end to a second end, the first end may be attached to a rotation point, the second end may be connected to the second arching contact when the switch is closed and remains connected to the second arcing contact during at least part of the opening operation of the switch, and the elastic connection may be attached to the secondary arcing contact between the first end and the second end.

[0006] The secondary arcing contact may be electrically connected to the movable electrical contact assembly by a braided electrical wire.

[0007] The first arcing contact, the second arcing contact, and the secondary arcing contact may have a lower electrical conductivity than the first stationary electrical contact, the second stationary electrical contact, and the movable electrical contact assembly.

[0008] The movable electrical contact assembly may be attached to the second stationary electrical contact at a pivot point, the movable electrical contact assembly may be configured to rotate about the pivot point in an arc, and the secondary arcing contact may remain connected to the second arcing contact at least until the first arcing contact connects to the second arcing contact.

[0009] The movable electrical contact assembly may include: a first contact portion, and a second contact portion. The first contact portion may be on a first side of the second stationary electrical contact, and the second contact portion may be on a second side of the second stationary electrical contact.

[0010] The switch also may include a pressure apparatus coupled to the movable electrical contact assembly, and the opening operation may begin when the pressure apparatus is released. The switch also may include an operating interface coupled to the pressure apparatus, the operating interface being operable to release the pressure apparatus.

[0011] The switch also may include a support, and the first stationary electrical contact and the second stationary electrical contact may be mounted on the support in a line.

[0012] In another aspect, an apparatus includes: a movable electrical contact assembly configured to move relative to a stationary electrical contact; an arcing contact attached to the movable electrical contact assembly; a secondary arcing contact electrically connected to the movable electrical contact assembly; and an elastic connection attached to the movable electrical contact assembly and the secondary arcing contact.

[0013] Implementations may include one or more of the following features.
[0014] The secondary arcing contact may be electrically connected to the movable electrical contact assembly through an electrically conductive element. The electrically conductive element may be flexible.
[0015] The movable electrical contact assembly may include a first contact portion and a second contact portion, and the secondary arcing contact may be between the first contact portion and the second contact portion.
[0016] The secondary arcing contact and the arcing contact may include a first electrically conductive material, and the movable electrical contact assembly may include a second electrically conductive material that has a higher electrical conductivity than the first electrically conductive material.
[0017] In another aspect, a system includes: a stationary electrical contact; a movable electrical contact assembly configured to move relative to the stationary electrical contact; a first arcing contact on the movable electrical contact assembly; a second arcing contact on the stationary electrical contact; an electrical element electrically connected to the movable electrical contact assembly; an elastic connection attached to the movable electrical contact assembly; and a secondary arcing contact connected to the electrical element and the elastic connection.
[0018] Implementations of any of the techniques described herein may include an apparatus, a device, a switch, a system, and/or a method. The details of one or more implementations are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

Description

DRAWING DESCRIPTION
[0019] FIG. **1** is a block diagram of a switching system.
[0020] FIG. **2**A is a perspective view of a switch module.
[0021] FIG. **2**B is a side view of a pressure contact switching system that includes the switch module of FIG. **2**A.
[0022] FIG. **3** is a top view of another switch module.
[0023] FIG. **4**A is a side view of a contact portion along the line **4**A-**4**A′ of FIG. **3**.
[0024] FIG. **4**B is a side view of another contact portion along the line **4**B-**4**B′ of FIG. **3**.
[0025] FIG. **5** is a side view of a stationary contact of the switch module of FIG. **3**.
[0026] FIG. **6**A is a side view of the switch module of FIG. **3** in a closed configuration.
[0027] FIGS. **6**B and **6**C are side views of the switch module of FIG. **3** during an opening operation.
[0028] FIG. **6**D is a side view of the switch module of FIG. **3** in a fully open configuration.
DETAILED DESCRIPTION
[0029] FIG. **1** is a block diagram of a switching system **110** that is between two devices **101** and **102**. In the discussion below, the device **101** is a source **101** and the device **102** is a load **102**. However, devices **101** and **102** may be any type of electrical device. For example, the device **101** may be a load and the device **102** may be a source. The switching system **110** may be, for example, a safety switch, a shunt trip safety switch, a fused and/or power-circuit device, or a molded case circuit breaker. The switching system **110** includes a switch apparatus **130**. The switch apparatus **130** may be, for example, a bolted contact switch, a high pressure butt-type contact switch, or a bolted pressure switch apparatus.
[0030] The switch apparatus **130** includes a switch module **140** that controls the electrical connection between the source **101** and the load **102**. The switch module **140** includes a stationary contact **144** and a movable contact **142** that moves relative to the stationary contact **144** to open or

close the switch module **140**. The contacts **142** and **144** are electrically conductive. When the movable contact **142** is not electrically connected to the stationary contact **144**, the switch module **140** is OFF or open, current cannot flow through the switch module **140**, and the source **101** is disconnected from the load **102**. When the movable contact **142** is electrically connected to the stationary contact **144**, the switch module **140** is ON or closed, current can flow through the switch module **140**, and the source **101** is electrically connected to the load **102**.

[0031] As discussed below, the switch module **140** includes a secondary arcing contact **146** that provides an alternate current path during an opening operation of the switch module **140**. The secondary arcing contact **146** reduces and/or eliminates contact welding that could otherwise occur between the movable contact **142** and the stationary contact **144** during the opening operation.

[0032] Before discussing examples of the switch module **140** in more detail, an overview of various components of the system **100** is provided.

[0033] The source **101** is any kind of AC power source. For example, the source **101** may be a generator, a power plant, a distributed energy resource (DER), or a node or feeder in an AC power grid. A DER is an electricity-producing resource and/or a controllable load. Examples of DERs include, without limitation, solar-based energy sources such as, for example, solar panels and solar arrays; wind-based energy sources, such as, for example, wind turbines and windmills; combined heat and power plants; rechargeable sources (such as batteries); natural gas-fueled generators; electric vehicles; and controllable loads, such as, for example, some heating, ventilation, air conditioning (HVAC) systems, and electric water heaters.

[0034] The load **102** is any device or system that consumes, transfers, absorbs, and/or produces electrical power. For example, the load **102** may be a motor; a lighting system; a distributed energy resource (DER); an uninterruptable power supply, a capacitor, a power-factor correction device (such as a capacitor bank), or a transformer. The load **102** may be located at a customer site, such as, for example, a residence or an industrial facility. The load **102** may include more than one device.

[0035] In the example of FIG. **1**, the source **101** is part of a grid or electrical power distribution network **103**. The electrical power distribution network **103** may be, for example, a multi-phase electrical power grid that provides electricity to industrial, commercial, and/or residential customers. The AC electrical power distribution network **103** distributes AC electrical power that has a fundamental frequency of, for example, 50 or 60 Hertz (Hz). The AC electrical power distribution network **103** may be low-voltage (for example, up to 1 kilovolt (kV)), medium-voltage or distribution voltage (for example, between 1 kilovolts (kV) and 35 kV), or high-voltage (for example, 35 kV and greater).

[0036] The distribution network **103** may include more than one sub-grid or portion. For example, the distribution network **103** may include AC micro-grids, AC area networks, or AC spot networks that serve particular customers. These sub-grids may be connected to each other via switches and/or other devices to form the network **103**. Moreover, sub-grids within the network **103** may have different nominal voltages. For example, the network **103** may include a medium-voltage portion connected to a low-voltage portion through a distribution transformer.

[0037] All or part of the network **103** may be underground. The network **103** may include additional components and devices such as, for example, one or more transmission lines, distribution lines, power distribution or substation transformers, electrical cables, and/or any other mechanism for transmitting electricity.

[0038] The switch apparatus **130** is supported and/or enclosed in a housing **111**. The state of the switch apparatus **130** is determined by the state of the switch module **140**. The switch module **140** is any type of switch that has at least an ON state and an OFF state. For example, the switch module **140** may be a double make, double break switch that includes a movable conductor and that interacts with two stationary contacts, a knife-type switch, a bolted pressure contact switch, a high-pressure butt-type contact switch, or a blade-type switch. The switch module **140** is

configured for repeated operation. For example, the switch module **140** may be opened and closed repeatedly over its lifetime.

[0039] The switch module **140** is capable of interrupting current having an amplitude that is appropriate for the application of the switching system **110**. The rating of the switching system **110** may be, for example, 30 Amperes (A), 60 A, 100 A, 200 A, 400 A, 600 A, 800 A, 1200 A, or greater. Although only one switch module **140** is shown in FIG. **1**, the switch apparatus **130** may include more than one switch module **140**. For example, the switch apparatus **130** may be a three-phase switch apparatus that includes three instances of the switch module **140**, one for each phase. In some implementations, the switch apparatus **130** is a multi-phase switch apparatus that includes more than one instance of the switch module **140** for each phase.

[0040] The switching system **110** also includes an operating interface **190** and a driving assembly **195** coupled to the operating interface **190**. The driving assembly **195** is coupled to the movable contact **142** such that the state of the switch module **140** is controllable with the operating interface **190**. In implementations that include more than one instance of the switch module **140**, the driving assembly **195** is coupled to all of the switch modules **140** such that manipulating the operating interface **190** changes the state of all of the switch modules **140** simultaneously to thereby also change the state of the switch apparatus **130**.

[0041] The operating interface **190** is any type of interface that has at least two stable states or positions and is accessible from an exterior of the support or housing **111**. For example, the operating interface **190** may be a handle that moves through a range of motion between two endpoints but is only stationary at the endpoints, where one endpoint corresponds to the switch apparatus **130** being in the OFF state and the other endpoint corresponds to the switch apparatus **130** being in the ON state.

[0042] The switching system **110** also may include a fuse holding assembly (not shown). The fuse holding assembly is any type of assembly that holds fuses. For example, the fuse holding assembly may be one or more fuse clips. The fuse holding assembly may be configured to allow removal and replacement of a fuse that has operated. In implementations that include a fuse holding assembly, the switching system **110** may be shipped or transported without the fuses and the fuses may be installed by the end-user or manufacturer. However, the switching system **110** may be used without fuses and may be constructed without a fuse holding assembly.

[0043] FIG. **2**A is a perspective view of a switch module **240**. The switch module **240** is a bolted pressure contact switch that includes a secondary arcing contact **246**. FIG. **2**A shows the switch module **240** in a fully open state or fully open position.

[0044] The switch module **240** includes a movable contact assembly **242** and stationary contacts **244** and **245**. In the example shown in FIG. **2**A, the stationary contacts **244** and **245** are solid bars of electrically conductive material. Other implementations are possible. For example, the stationary contacts **244** and **245** may be blades or rods of electrically conductive material.

[0045] The stationary contacts **244** and **245** are attached to a support **211**. The support **211** may be, for example, a mounting board, housing, enclosure, or other structure. The support **211** includes a material that is not electrically conductive, such as, for example, a polymer. The stationary contacts **244** and **245** are attached to the support **211** with one or more mechanical fasteners (for example, brackets, screws, and/or bolts) and/or with a bonding agent (for example, an adhesive).

[0046] The stationary contact **244** extends in the Y direction from a first end **249** to a second end **250**. The stationary contact **244** has a generally planar surface **251** that extends in the X-Y plane and has a thickness **252** in the Z direction. The stationary contact **244** also includes a substantially planar surface opposite the surface **251** that is not shown in FIG. **2**A. The stationary contact **244** includes a recessed region **253** near the end **249**.

[0047] The stationary contact **244** also includes an arcing contact **241** that extends from an upper part of the stationary contact **244**. The arcing contact **241** is fixedly attached to the stationary contact **244** and does not move relative to the stationary contact **244**. For example, the arcing

contact **241** may be bolded, welded, and/or brazed to the stationary contact **244**.
[0048] The stationary contact **245** extends in the Y direction from an end **260** to an end **261**. The stationary contact **245** includes a substantially planar surface **263** that extends in the X-Y plane. The stationary contact **245** also includes a substantially planar surface that is opposite the surface **263** and is not shown in FIG. **2**A. The stationary contact **244** and the stationary contact **245** are positioned along a line in the Y direction. The stationary contacts **244** and **245** do not make direct physical contact.
[0049] The movable contact assembly **242** includes a first contact portion **247** and a second contact portion **248**. Each contact portion **247**, **248** is an electrically conductive bar or plate. The contact portions **247** and **248** are separated from each other in the Z direction and do not make direct physical contact. The contact portions **247** and **248** are mounted to the stationary contact **245** at a pivot point **264**. The first contact portion **247** and second contact portion **248** are mounted on opposite sides of the stationary contact **245**, with the first contact portion **247** being on the side of the surface **263**.
[0050] The pivot point **264** passes through the first contact portion **247**, the second contact portion **248**, and the stationary contact **245** in the Z direction. The pivot point **264** is any type of device that allows the movable contact assembly **242** to rotate relative to the stationary contact **245** along an arc **265** in the X-Y plane. For example, the pivot point **264** may be a rivet, a bolt, or a screw. The movable contact assembly **242** also includes a pressure apparatus **266** that passes through the first contact portion **247** and the second contact portion **248** in the Z direction. The pressure apparatus **266** is any device that can press the contact portions **247** and **248** toward each other. The pressure apparatus **266** may be, for example, a bolt that passes through the contact portions **247** and **248** in the Z direction and is secured by a nut or other fastener.
[0051] Each contact portion **247**, **248** includes a respective arcing contact **243***a*, **243***b*. Each arcing contact **242***a*, **243***b* is fixedly attached to its respective contact portion **247**, **248**. For example, the arcing contact **243***a* may be bolted, welded, and/or brazed to the contact portion **247**, and the arcing contact **243***b* may be bolted, welded, and/or brazed to the contact portion **248**. The secondary arcing contact **246** is between the first contact portion **247** and the second contact portion **248**. The secondary arcing contact **246** is electrically connected to the first contact portion **247** and/or the second contact portion **248**.
[0052] The stationary contacts **244**, **245** and the contact portions **247**, **248** are made of an electrically conductive material, such as, for example, copper, gold, silver, or a metal alloy. The secondary arcing contact **246** and the arcing contacts **241**, **243***a*, and **243***b* are also made of an electrically conductive material. The secondary arcing contact **246**; the arcing contacts **243***a*, **243***b*; and the arcing contact **241** may be made of the same material. The arcing contacts **243***a*, **243***b*, **241**, and the secondary arcing contact **246** are not necessarily the same material as the stationary contacts **244**, **245** and the contact portions **247**, **248**. Moreover, the arcing contacts **241**, **246**, **243***a*, and **243***b* may be made of a material with a higher impedance (or lower electrical conductivity) that the material of the stationary contacts **244**, **245** and the contact portions **247**, **248** to reduce electrical loses during ordinary operation of the switch module **240**. The arching contacts **241**, **243***a*, **243***b* and the secondary arcing contact **246** may include, for example, copper, silver, or a metal alloy (for example, copper-tungsten, silver-tungsten) or any other electrically conductive material with high melting point.
[0053] FIG. **2**B is a side view of a pressure contact switching system **210** that includes the switch module **240** and the support **211**. The switch module **240** is in the closed state in FIG. **2**B. The switching system **210** includes an operating interface **290** that is coupled to a shaft **295**. The shaft **295** extends along the Z axis (into and out of the page in FIG. **2**B). The shaft **295** is connected via mechanical linkages **296** and **297** to the pressure apparatus **266**.
[0054] To open the switch module **240**, the operating interface **290** is manipulated and the shaft **295** rotates in the X-Y plane, moving the linkages **296** and **297**. The linkage **297** is mechanically

connected to the pressure apparatus **266**. Moving the linkage **297** loosens the pressure apparatus **266** (for example, a bolt or fastener), thereby releasing the contact portions **247** and **248** from the stationary contact **244** to begin the opening procedure. The operating interface **290** is also used to close the switch module **240**. As the switch module **240** finishes closing, the movable contact assembly **242** continues to move thereby tightening the bolt or fastener of the pressure apparatus. This tightening process effectively bolts the movable contact assembly **242** to the stationary contacts **244** and **245**, and the switch module **240** is closed.

[0055] FIG. **3** is a top view of a switch module **340**. The switch module **340** is similar to the switch module **240**. The switch module **340** may be mounted on the support **211** (FIGS. **2**A and **2**B) and may be used in the switch apparatus **130** (FIG. **1**). FIG. **3** shows the switch module **340** in the closed position.

[0056] The switch module **340** includes a first stationary contact **344** and a second stationary contact **345**. The first stationary contact **344** and the second stationary contact **345** are electrically conductive elements, for example, the contacts **344** and **345** may be metal bars. The first stationary contact **344** includes opposing substantially planar surfaces **351** and **368** that extend in the X-Y plane. The second stationary contact **345** includes opposing substantially planar surfaces **363** and **369**. An arcing contact **341** is affixed to the first stationary contact **344**.

[0057] The switch module **340** also includes a movable contact assembly **342**. The movable contact assembly **342** includes a first contact portion **347** and a second contact portion **348**. The contact portions **347** and **348** are not directly connected to each other and are separated in the Z direction. Each contact portion **347**, **348** includes a respective arcing contact **343***a*, **343***b*. Referring also to FIG. **4**A, which is a side view of the contact portion **348** along the line **4**A-**4**A′ of FIG. **3**, the arcing contact **343***b* extends from a lower portion of the contact portion **348**. As shown in FIG. **4**B, which is a side view of the contact portion **347** along the line **4**B-**4**B′ of FIG. **3**, the arcing contact **343***a* is positioned similarly on the contact portion **347**. The arcing contacts **343***a* and **343***b* are substantially parallel to each other.

[0058] A secondary arcing contact **346** is between the first contact portion **347** and **348**. The secondary arcing contact **346** is an electrically conductive material, such as, for example, copper. The secondary arcing contact **346** may be, for example, a strip, a bar, or a rod.

[0059] The secondary arcing contact **346** is attached to the first contact portion **347** and/or the second contact portion **348** at a connection point **371**. The connection point **371** is any type of connection that allows the secondary arcing contact **346** to move relative to the movable contact assembly **342**. For example, the connection point **371** may be a rivet or a post.

[0060] The secondary arcing contact **346** is also attached to the first contact portion **347** by an elastic connection **367**. The elastic connection **367** is attached to the first contact portion **347** and to the second contact portion **348** at a connection point **370**. The elastic connection **367** is any device or assembly that has an equilibrium position, an extended state, and a compressed state. The elastic connection **367** exerts a force in direction(s) that is toward its equilibrium state.

[0061] The elastic connection **367** may be, for example, a spring (for example, a tension spring), an elastic strip or band, or a rubber member. The connection point **370** may be an opening that receives a hook on one end of the elastic connection **367**, a pin, a screw or other fastener, and/or an adhesive.

[0062] The secondary arcing contact **346** is electrically connected to the second contact portion **348** by an electrically conductive element **373**. The electrically conductive element **373** is any type of electrical element that maintains electrical connection between the contact portions **347** and **348** and the secondary arcing contact **346** throughout opening and closing of the switch module **340** and at all positions of the movable contact assembly **342**. For example, the electrically conductive element **373** may be a braided copper wire or a cable that is soldered or brazed to the second contact portion **348** and to the secondary arcing contact **346**.

[0063] In some implementations, the secondary arcing contact is electrically connected to the first

contact portion **347** by the electrically conductive element **373**. Moreover, the movable contact assembly **342** may include more than one electrically conductive element **373**, and the secondary arcing contact **346** may be electrically connected to the contact portion **347** and the contact portion **348**. Moreover, in some implementations, the secondary arcing contact **346** is electrically connected to two instances of the element **373**, one of which is connected to the contact portion **347** and the other of which is connected to the contact portion **348**.

[0064] The movable contact assembly **342** is attached to the second stationary contact **345** at a pivot apparatus **364**. Portions of the pivot apparatus **364** (shown in dotted lines in FIG. **3** to indicate a hidden element) pass through the movable contact assembly **342** and the stationary contact **345** in the Z direction. The pivot apparatus **364** may be an axle, pin, bolt, or any other element that allows the movable contact assembly **342** to rotate relative to the second stationary contact **345** in the X-Y plane.

[0065] The movable contact assembly **342** also includes a pressure apparatus **366** that extends through the first and second contact portions **347**, **348** in the Z direction. The pressure apparatus **366** may be a bolt. Referring also to FIG. **5**, which is a side view of the first stationary contact **344**, the stationary contact **344** includes a recess **353** that accommodates the pressure apparatus **366** when the switch module **340** is in the closed position and during portions of the opening process. The first stationary contact **344** does not restrain the pressure apparatus **366**.

[0066] Referring again to FIG. **3**, when the switch module **340** is in the closed position, the pressure apparatus **366** presses the first and second contact portions **347**, **348** toward each other. The first contact portion **347** is in physical contact with the surface **351** of the first stationary contact **344** and the surface **363** of the second stationary contact **345**. The second contact portion **348** is in physical contact with the surface **368** of the first stationary contact **344** and the surface **369** of the second stationary contact **345**. Electrical current can flow through the switch module **380** when it is in the closed position.

[0067] FIGS. **6**A-**6**D show an opening operation to transition the switch module **340** from the closed position the fully open position. FIGS. **6**A-**6**D are side cross-sectional views of the switch module **340** in the X-Y plane taken along the line **4**A-**4**A′ of FIG. **3**. The stationary contacts **344** and **345** are in the foreground relative to the second contact portion **348**. However, for simplicity, the contact portion **348** is shown in solid lines. Moreover, only the second contact portion **348** is shown in FIGS. **6**A-**6**C. However, the first contact portion **347** moves in the same manner as discussed below with respect to the portion **348**.

[0068] In FIG. **6**A, the switch module **340** is closed. The first and second contact portions **347** and **348** are electrically connected to the stationary contacts **344** and **345**. The pressure apparatus **366** applies force along the Z axis (into and out of the page) to press the first and second contact portions **347**, **348** onto the stationary contact **344**. This helps to ensure a secure electrical connection between the first and second contact portions **347**, **348** and the stationary contact **344**. The secondary arcing contact **346** is in physical and electrical contact with the arcing contact **341**. The elastic connection **367** is in an extended or expanded state and exerts a force F on the secondary arcing contact **346** in a direction toward the equilibrium state of the elastic connection (substantially along the −X direction in FIG. **6**A). The force F holds the secondary arcing contact **346** to the arcing contact **341**. The impedance of the secondary arcing contact **346** and the arcing contact **341** is higher than the impedance of the contact portions **347**, **348** such that only a nominal amount of current flows in the secondary arcing contact **346** and the arcing contact **341** when the switch module **340** is closed.

[0069] To open the switch module **340**, the pressure apparatus **366** is loosened. The contact portions **347** and **348** move out of physical contact with the stationary contact **344**. Referring to FIG. **6**B, the contact portions **347** and **348** rotate about the pivot point along an arc **365**. As the contact portions **347** and **348** rotate, the elastic connection **367** continues to seek the equilibrium position and continues to apply the force F to the secondary arcing contact **346**. The force F holds

the secondary arcing contact **346** in physical and electrical contact with the arcing contact **341**. The secondary arcing contact **346** is electrically connected to the second contact portion **348** through the electrically conductive element **373**, which is electrically connected to the stationary contact **345**. Thus, current can continue to flow through the stationary contact **345**, the first and second contact portions **347**, **348**, into the secondary arcing contact **346**, and the stationary contact **344**. In other words, current can flow in the switch module **340** via the secondary arcing contact **346** during the initial parts of the opening operation.

[0070] Referring to FIG. **6**C, the first and second contact portions **347**, **348** continue to rotate along the arc **365**. The arcing contact **343***b* (and **343***a*) move into contact with the arc contact **341**. Current may flow through the arcing contacts **343***a*, **343***b*, and **341**. The elastic connection **367** is at its equilibrium position and the secondary arcing contact **346** may separate from the arcing contact **341**. In some implementations, the elastic connection **367** is at its equilibrium position when the first and second contact portions **347**, **348** are at an angle of about 25 degrees (°) relative to the Y axis.

[0071] Referring to FIG. **6**D, the contact portions **347** and **348** move along the arc **365** until the switch module **340** is fully open. No current flows in the switch module **340**.

[0072] The configuration of the arcing contact **346** and the ability to conduct current in the initial part of the opening operation may reduce contact welding on the stationary contact **344** and/or the contact portions **347**, **348**, thereby extending the life of the switch module **340**. For example, when the contact portions **347**, **348** move out of physical contact with the stationary contact **344** at the beginning of the opening operation, an air gap is formed between the contact portion **348** and the surface **368** of the stationary contact **344** and between the contact portion **347** and the surface **351** of the stationary contact **344**. Without the secondary arcing contact **346**, current flowing in the switch module **340** at the initiation of the opening procedure (for example, when the switch module **340** opens due to an overload or short circuit condition) would arc in the air gap (which has a very high impedance). Small (for example, ones, tens, or hundreds of micron) contact weld regions would be created on the surfaces **351** and **368** and/or on the contact portions **347**, **348**. This contact welding affects the electrical properties and integrity of the surface and may reduce the lifetime and/or hinder performance of the switch module.

[0073] On the other hand, the switch module **340** includes the secondary arcing contact **346**. As discussed above, the secondary arcing contact **346** provides a path for electrical current that flows during the opening procedure and before the arc contacts **343***a*, **343***b*, and **341** are available provide a current path. Examples of such current include, for example, fault current that arises from an overload or short circuit condition. In this way, the secondary arc contact **346** improves the performance of the switch module **340** and/or extends the usable life of the switch module **340**. Moreover, in some implementations, the elastic connection **367** is positioned such that the force F applied by the elastic connection **367** is maximum when the switch module **340** is in the closed position. This provides further assurance that the secondary arcing contact **346** remains in physical and electrical contact with the arcing contact **341** to provide a path for fault current when the pressure apparatus **366** releases the first and second contact portions **347**, **348** at the beginning of the opening operation.

[0074] These and other implementations are within the scope of the claims.

Claims

1. A switch comprising: a first stationary electrical contact; a second stationary electrical contact; a movable electrical contact assembly attached to the second stationary electrical contact and configured to separate from the first stationary electrical contact to open the switch; a first arcing contact on the movable electrical contact assembly; a second arcing contact on the first stationary electrical contact; and a secondary arcing contact electrically connected to the movable electrical

contact assembly, wherein the secondary arcing contact is connected to the second arcing contact when the switch is closed and remains connected to the second arcing contact during at least part of an opening operation of the switch.

2. The switch of claim 1, wherein the secondary arcing contact is attached to the movable electrical contact assembly with an elastic connection, and the elastic connection is configured to apply a force to the secondary arcing contact.

3. The switch of claim 2, wherein the force is greatest when the switch is closed.

4. The switch of claim 2, wherein the secondary arcing contact extends from a first end to a second end, the first end is attached to a rotation point, the second end is connected to the second arching contact when the switch is closed and remains connected to the second arcing contact during at least part of the opening operation of the switch, and the elastic connection is attached to the secondary arcing contact between the first end and the second end.

5. The switch of claim 1, wherein the secondary arcing contact is electrically connected to the movable electrical contact assembly by a braided electrical wire.

6. The switch of claim 1, wherein the first arcing contact, the second arcing contact, and the secondary arcing contact have a lower electrical conductivity than the first stationary electrical contact, the second stationary electrical contact, and the movable electrical contact assembly.

7. The switch of claim 1, wherein the movable electrical contact assembly is attached to the second stationary electrical contact at a pivot point, the movable electrical contact assembly is configured to rotate about the pivot point in an arc, and the secondary arcing contact remains connected to the second arcing contact at least until the first arcing contact connects to the second arcing contact.

8. The switch of claim 1, wherein the movable electrical contact assembly comprises: a first contact portion, and a second contact portion, wherein the first contact portion is on a first side of the second stationary electrical contact, and the second contact portion is on a second side of the second stationary electrical contact.

9. The switch of claim 1, further comprising a pressure apparatus coupled to the movable electrical contact assembly, and, wherein, the opening operation begins when the pressure apparatus is released.

10. The switch of claim 9, further comprising an operating interface coupled to the pressure apparatus, the operating interface being operable to release the pressure apparatus.

11. The switch of claim 1, further comprising a support, and wherein the first stationary electrical contact and the second stationary electrical contact are mounted on the support in a line.

12. An apparatus comprising: a movable electrical contact assembly configured to move relative to a stationary electrical contact; an arcing contact attached to the movable electrical contact assembly; a secondary arcing contact electrically connected to the movable electrical contact assembly; and an elastic connection attached to the movable electrical contact assembly and the secondary arcing contact.

13. The apparatus of claim 12, wherein the secondary arcing contact is electrically connected to the movable electrical contact assembly through an electrically conductive element.

14. The apparatus of claim 13, wherein the electrically conductive element is flexible.

15. The apparatus of claim 12, wherein the movable electrical contact assembly comprises a first contact portion and a second contact portion, and the secondary arcing contact is between the first contact portion and the second contact portion.

16. The apparatus of claim 12, wherein the secondary arcing contact and the arcing contact comprise a first electrically conductive material, and the movable electrical contact assembly comprises a second electrically conductive material that has a higher electrical conductivity than the first electrically conductive material.

17. A system comprising: a stationary electrical contact; a movable electrical contact assembly configured to move relative to the stationary electrical contact; a first arcing contact on the movable electrical contact assembly; a second arcing contact on the stationary electrical contact; an

electrical element electrically connected to the movable electrical contact assembly; an elastic connection attached to the movable electrical contact assembly; and a secondary arcing contact connected to the electrical element and the elastic connection.