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(54) **ARC CHUTE FOR AN ELECTRICAL SWITCH**

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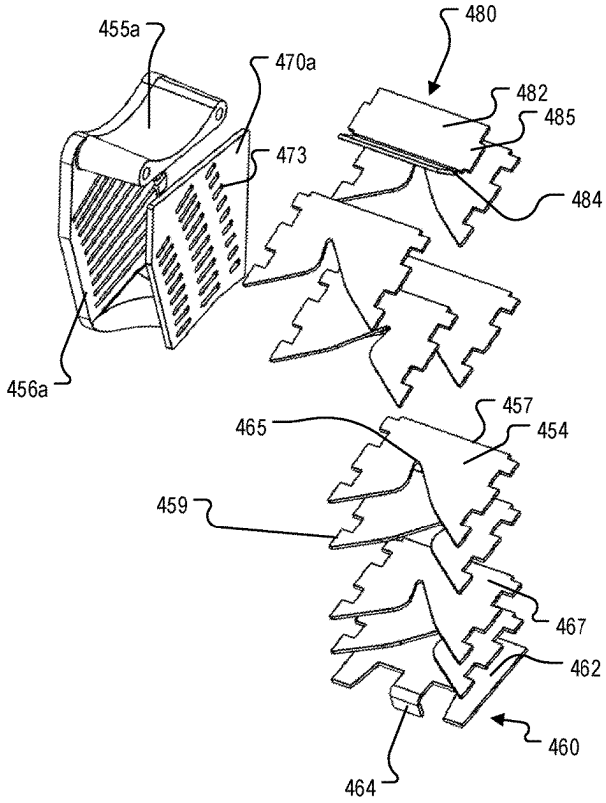
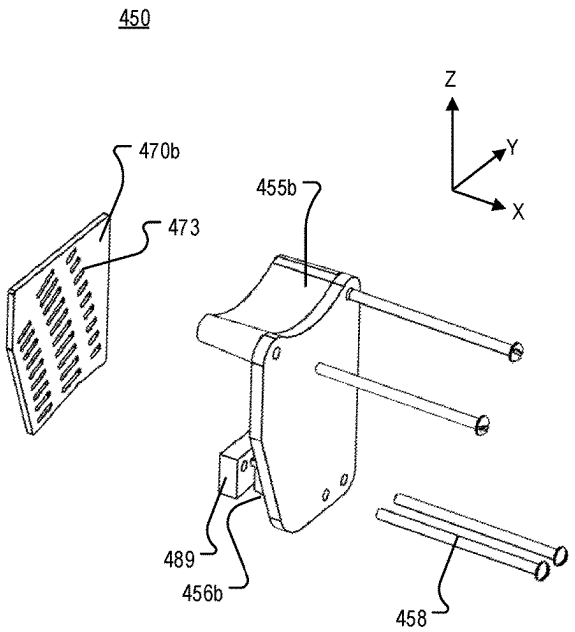
(57) **ABSTRACT**

An arc chute apparatus includes: a housing that includes a first sidewall, a second sidewall, and an arc runner. The arc runner includes: a base portion integral with the housing and extending between the first sidewall and the second sidewall; and a tab that extends from the base portion and is configured to be oriented toward an electrical contact of a switching device. The arc runner is a ferrous material. The arc chute apparatus also includes an arc guide between the first sidewall and the second sidewall; an ablative insert in the housing; and mounting features configured to hold a plurality of ferrous plates in a spaced apart arrangement in the housing between the first sidewall and the second sidewall and between the arc guide and the arc runner.





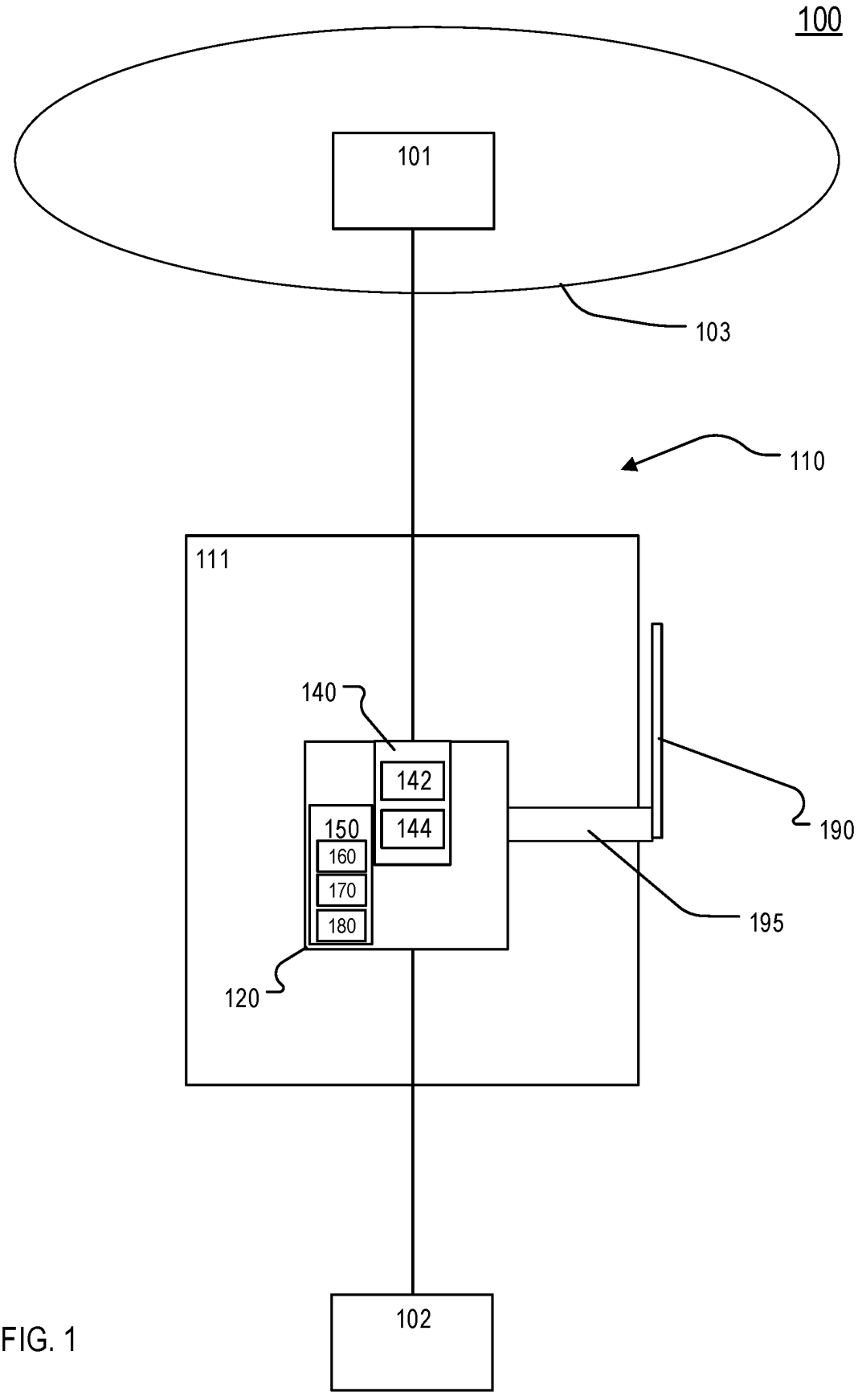


FIG. 1

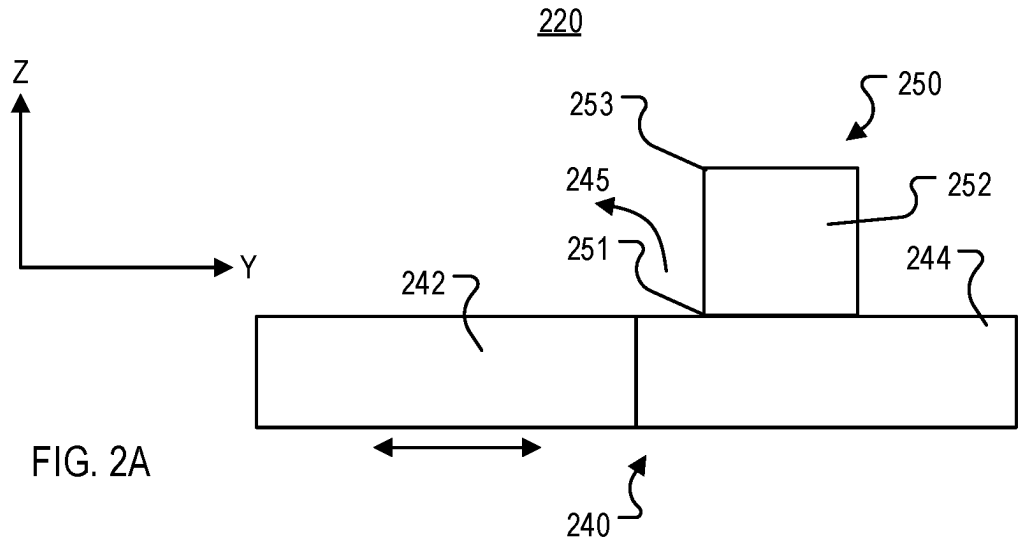

220
Z
Y
253
250
245
252
251
244
242
240

FIG. 2A

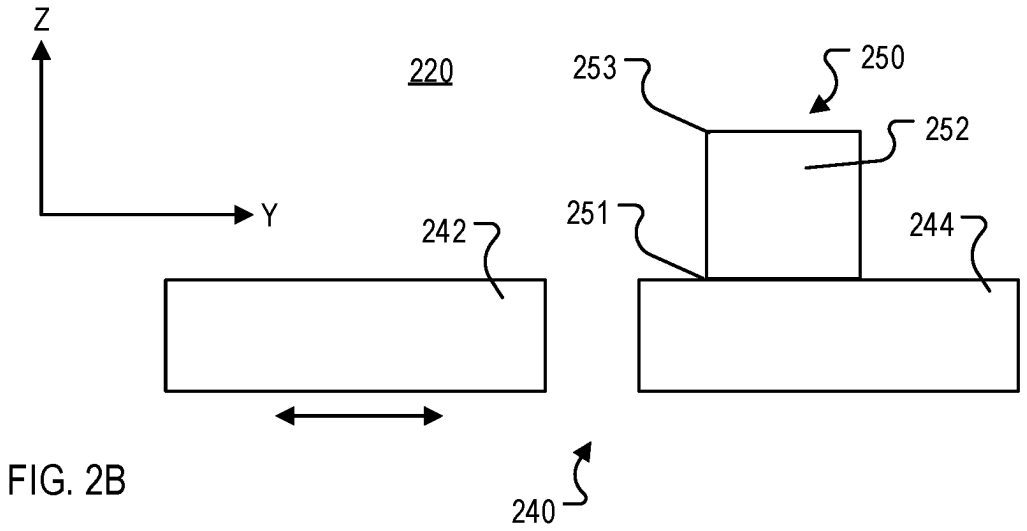

Z
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FIG. 2B

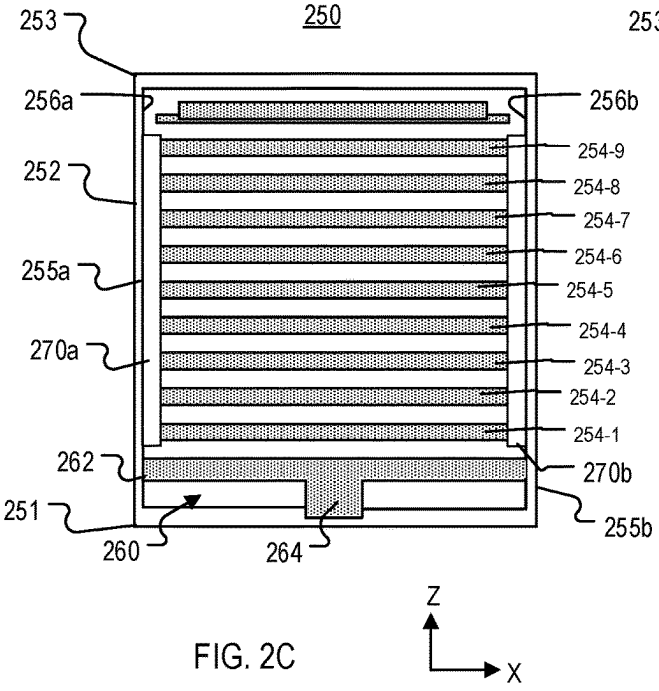


FIG. 2C

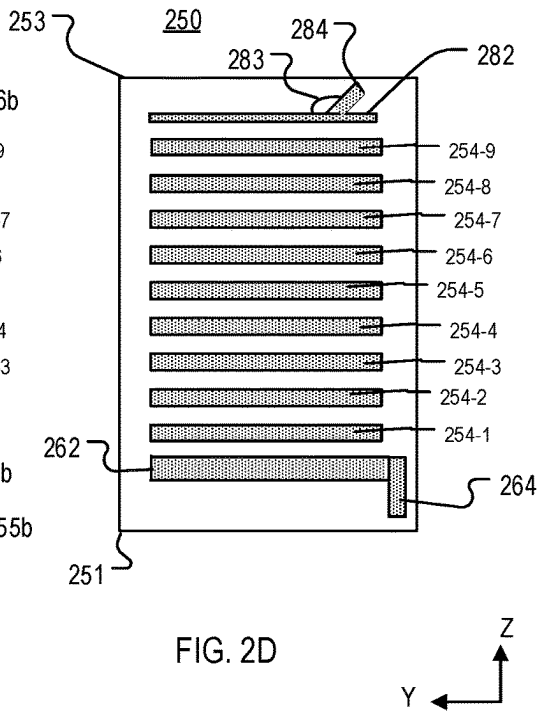


FIG. 2D

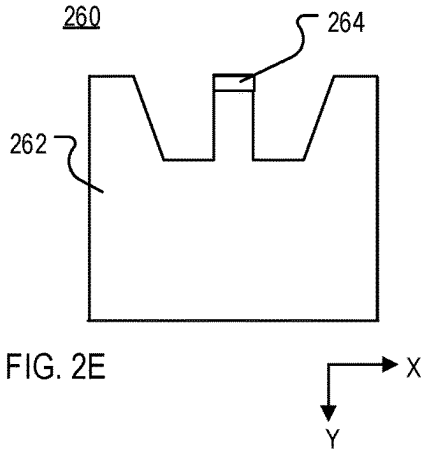


FIG. 2E

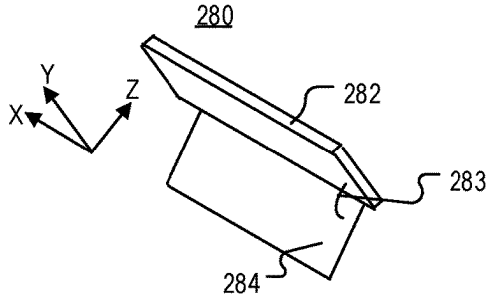


FIG. 2F

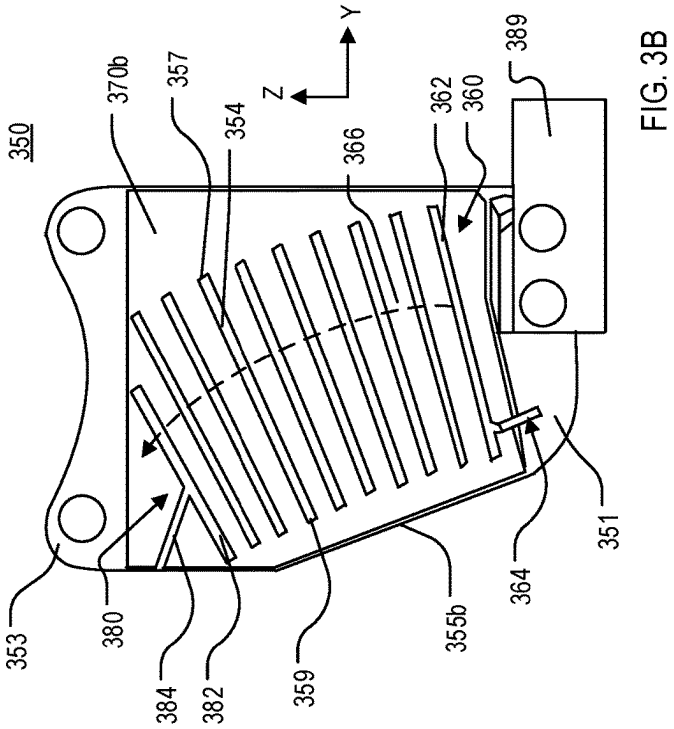


FIG. 3B

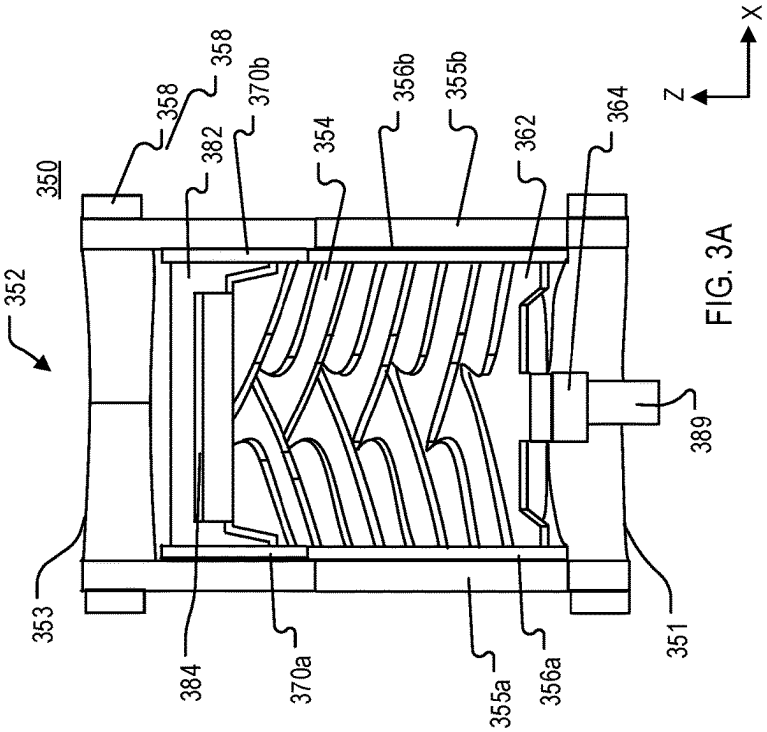


FIG. 3A

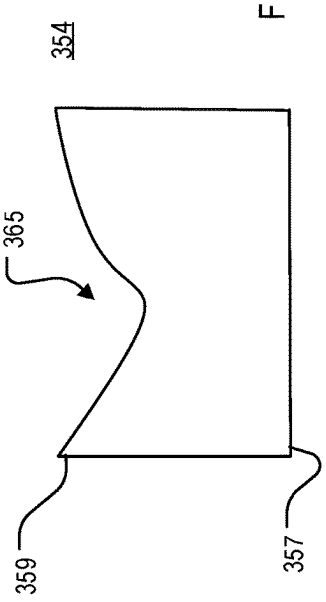
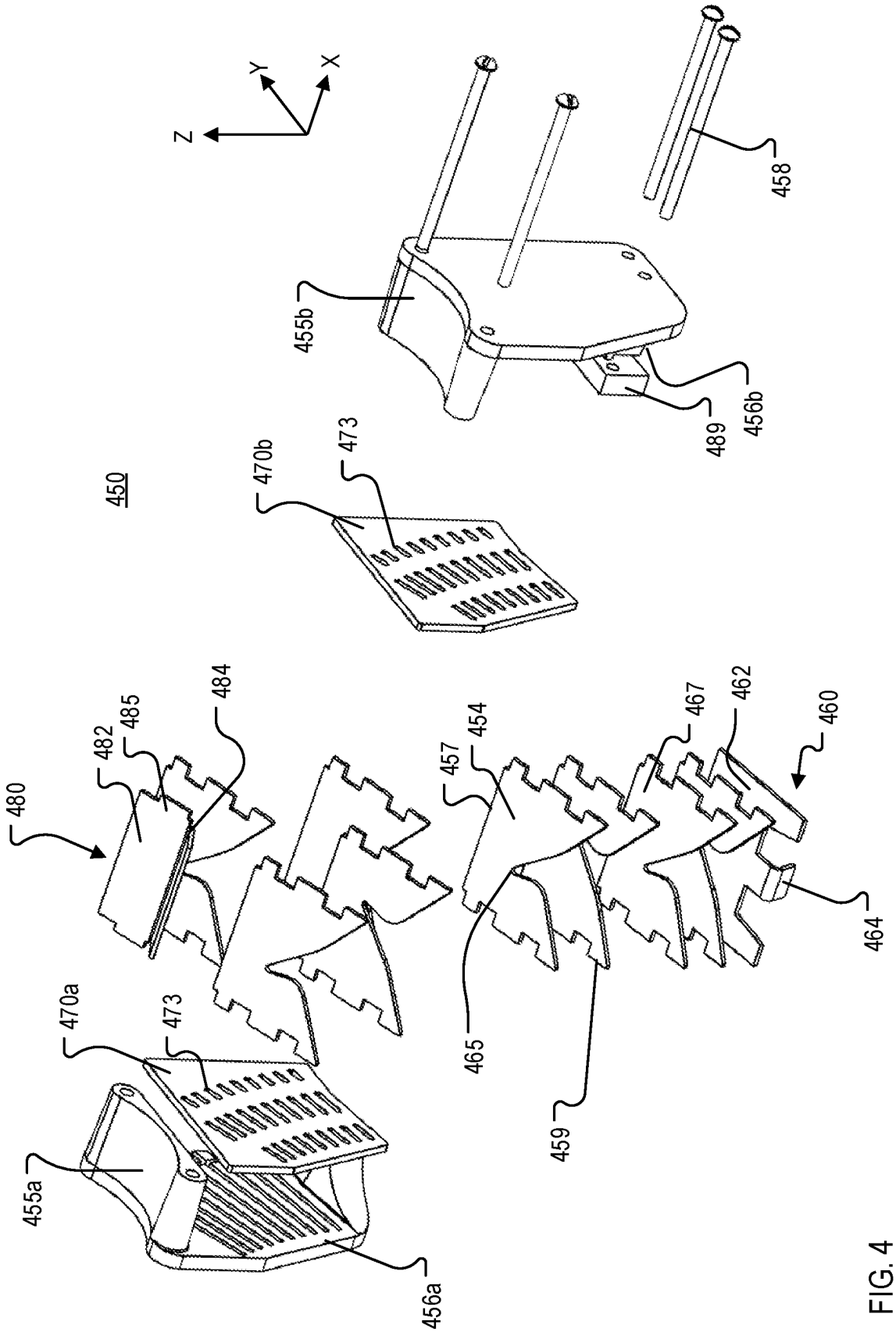


FIG. 3C


Z
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X
458
455b
456b
489
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470b
473
480
482
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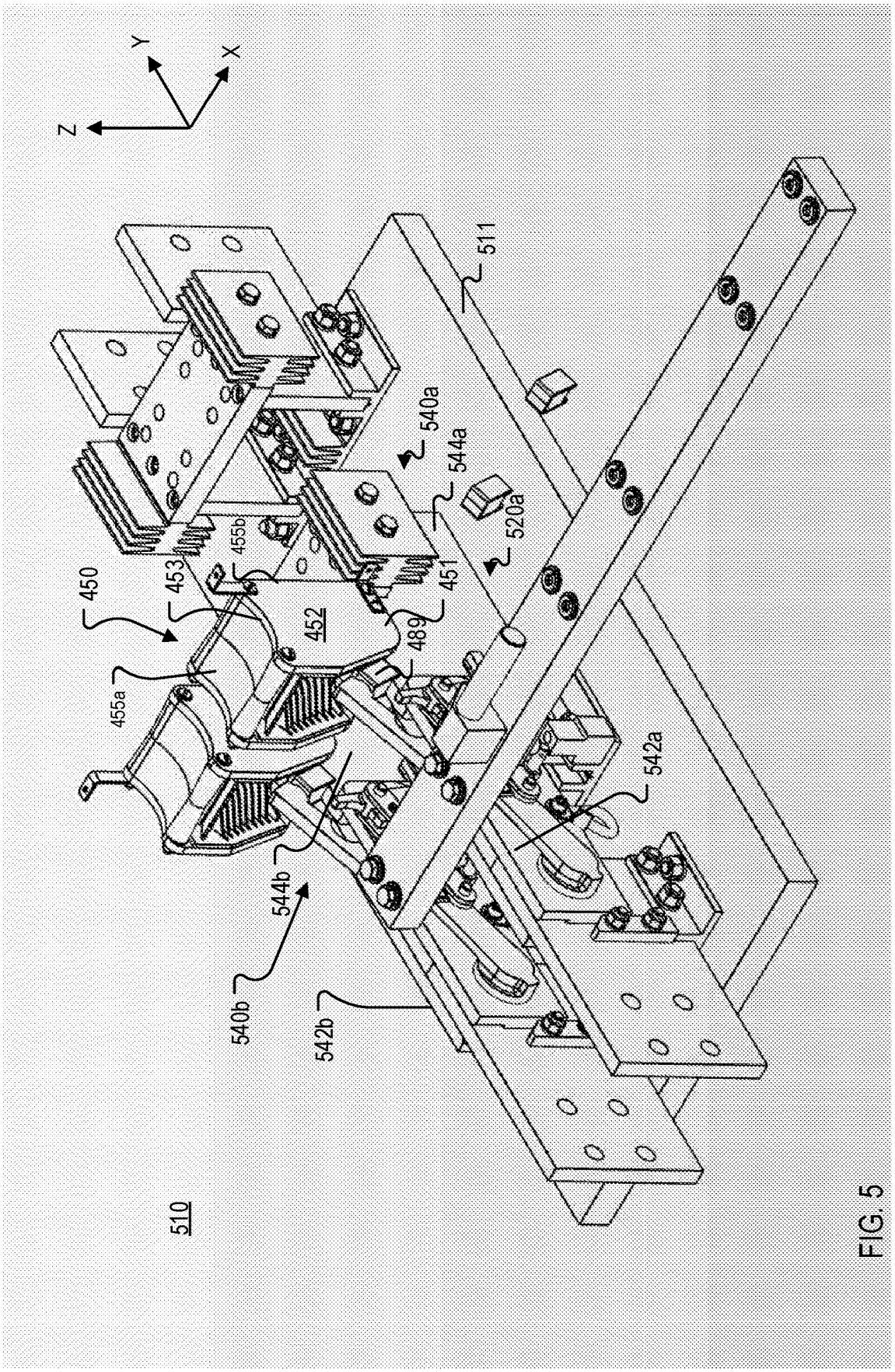
465
459
470a
473
455a
456a

FIG. 4


Y
X
Z
511
540a
544a
520a
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452
489
455a
542a
544b
540b
542b
510

FIG. 5

ARC CHUTE FOR AN ELECTRICAL SWITCH

TECHNICAL FIELD

[0001] This disclosure relates to an arc chute for an electrical switch.

BACKGROUND

[0002] An electrical switch includes a stationary electrical contact 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 contact.

SUMMARY

[0003] In one aspect, an arc chute apparatus includes a housing that includes a first sidewall, a second sidewall, and an arc runner. The arc runner includes: a base portion integral with the housing and extending between the first sidewall and the second sidewall; and a tab that extends from the base portion and is configured to be oriented toward an electrical contact of a switching device. The arc runner is a ferrous material. The arc chute apparatus also includes an arc guide between the first sidewall and the second sidewall; an ablative insert in the housing; and mounting features configured to hold a plurality of ferrous plates in a spaced apart arrangement in the housing between the first sidewall and the second sidewall and between the arc guide and the arc runner.

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

[0005] The base portion may be planar and the tab may extend in a different plane than the base portion. The tab may extend perpendicularly from the base portion.

[0006] The arc guide may include: a guide plate that extends between the first sidewall and the second sidewall, and a retention portion.

[0007] The ablative insert may include a first ablative insert adjacent to the first sidewall, and a second ablative insert adjacent to the second sidewall. The mounting features may include openings in the first ablative inert and openings in the second ablative insert.

[0008] The mounting features may include: a first mounting plate on an inner side of the first sidewall, a second mounting plate on an inner side of the second sidewall. The first mounting plate and the second mounting plate may be identical and include a plurality of openings each configured to receive a mounting portion of a ferrous plate or a mounting portion of the arc guide.

[0009] In another aspect, a switching device includes: a first electrical contact; a second electrical contact configured to move relative to the first electrical contact; and an arc chute apparatus. The arc chute apparatus includes: a housing with a first sidewall, a second sidewall, and an arc runner, the arc runner including: a base portion integral with the housing and extending between the first sidewall and the second sidewall, and a tab that extends from the base portion and is configured to be oriented toward one or more of the first electrical contact and the second electrical contact. The arc runner includes a ferrous material.

[0010] Implementations may include one or more of the following features.

[0011] The switching device also may include mounting features configured to hold a plurality of ferrous plates between the first sidewall and the second sidewall. The arc chute apparatus also may include an arc guide and mounting features configured to hold the plurality of ferrous plates between the arc guide and the arc runner.

[0012] The arc chute apparatus may be configured to be mounted to the first electrical contact.

[0013] The arc chute apparatus also may include an ablative insert in the housing. The ablative insert may include a first ablative insert adjacent to the first sidewall, and a second ablative insert adjacent to the second sidewall.

[0014] In another aspect, a housing assembly for an arc chute includes: a first sidewall; a second sidewall; interior mounting features configured to hold a plurality of ferrous plates between an interior side of the first sidewall and an interior side of the second sidewall; and an arc runner including: a base portion and a tab that extends from the base portion. An exterior of the housing assembly is configured for mounting to an electrical contact of a switching apparatus, the base portion is integrally attached to the interior side of the first sidewall and the interior side of the second sidewall, the base portion and the tab include a ferrous material, and the tab is configured to be positioned toward an arc generating location of the switching apparatus.

[0015] Implementations may include one or more of the following features.

[0016] The housing assembly also may include an arc guide.

[0017] The housing assembly also may include an ablative insert.

[0018] The interior mounting features may be openings in the ablative insert.

[0019] Implementations of any of the techniques described herein may include an apparatus, a device, a system, an arc chute apparatus, a housing for an arc chute apparatus, a switch, 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.

DRAWING DESCRIPTION

[0020] FIG. **1** is a block diagram of a system.

[0021] FIGS. **2**A and **2**B are side views of a switch apparatus that includes an arc chute.

[0022] FIG. **2**C is a front view of the arc chute of FIGS. **2**A and **2**B.

[0023] FIG. **2**D is a cross sectional side view of the arc chute of FIGS. **2**A and **2**B.

[0024] FIG. **2**E is an arc runner that is part of the arc chute of FIGS. **2**A and **2**B.

[0025] FIG. **2**F is a perspective view of the arc guide that is part of the arc chute of FIGS. **2**A and **2**B.

[0026] FIG. **3**A is a front view of another arc chute.

[0027] FIG. **3**B is a cross-sectional view of the arc chute of FIG. **3**A.

[0028] FIG. **3**C is a plan view of a splitter plate that is part of the arc chute of FIG. **3**A.

[0029] FIG. **4** is a perspective exploded view of another arc chute.

[0030] FIG. **5** is a perspective assembled view of the arc chute of FIG. **4** mounted to a switch apparatus.

DETAILED DESCRIPTION

[0031] FIG. **1** is a block diagram of a system **100**. The system **100** includes a switching system **110** that controls an electrical connection between a source **101** and a load **102**. The switching system **110** may be, for example, a safety switch, a shunt trip safety switch, a circuit breaker (for example, a molded case circuit breaker), a switchgear, or a recloser.

[0032] The switching system **110** includes a switch apparatus **120**. The switch apparatus **120** includes a switch module **140**, which 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**. When the movable contact **142** is not electrically connected to the stationary contact **144**, the switch module **140** is OFF or open, 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, and the source **101** is electrically connected to the load **102**.

[0033] The switch apparatus **120** also includes an arc chute **150** that dissipates arcs that can form when the switch module **140** opens. To open the switch apparatus **120**, the movable contact **142** is separated from the stationary contact **144**. If current is flowing in the switch module **140** when the movable contact **142** separates from stationary contact **144**, an arc may form in the space between the movable contact **142** and the stationary contact **144**. Such an arc is generally undesirable. For example, the arc can electrically connect the stationary contact **144** and the movable contact **142** even though the contacts **144** and **142** are not in direct physical contact. Thus, the arc may provide a path for current to flow in the switch module **140** when the switch module **140** is intended to be open. Additionally, the arc can vaporize the surface of the stationary contact **144** and/or the movable contact **142**. The vaporization may degrade the contact **142** and/or **144** and reduce the life of the switch module **140**.

[0034] The arc chute **150** dissipates and/or extinguishes the arc. The arc chute **150** houses an integral arc runner **160**, an ablative material insert **170**, an arc guide **180**, and splitter plates (such as shown in FIGS. **2**A-**2**C) to increase the ability of the arc chute **150** to dissipate arcs. The arc runner **160** is integral with the arc chute **150** such that when the arc chute **150** is removed from the switch apparatus **120**, the arc runner **160** is also removed. The arc runner **160** pulls the arc into the arc chute **150** and the arc guide **180** encourages the arc to remain in the arc chute **150**, thereby increasing the exposure of the arc to the ablative material insert **170** and quenching the arc. Retaining the arc in the arc chute **150** also eliminates or reduces discharge of hot gasses and plasma into the environment around the switch apparatus **120**. The arc chute **150** may dissipate an arc created by opening a switch rated for 800 or 1000 Volt (V) switching in an air switching medium. Furthermore, the configuration of the arc chute **150** allows for a visible break or visible blade feature in the switch apparatus **120**. For example, the arc chute **150** design and placement is in such a way that, when the moveable contact **142** is moved from one position to another, the position of the moveable contact **142** is visible from a door viewing window of the switch apparatus **120**. The arc chute **150** do not obstruct the visibility of the movable contact **142** as viewed from switch front.

[0035] Before discussing examples of the arc chute **150** in more detail, an overview of various components of the system **100** is provided.

[0036] 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; 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.

[0037] 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.

[0038] 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).

[0039] 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.

[0040] 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.

[0041] The switch apparatus **120** is supported and/or enclosed in a housing **111**. The state of the switch apparatus **120** 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, 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.

[0042] 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 **120** may include more than one switch module **140**. For example, the switch apparatus **120** may be a three-phase switch apparatus that includes three instances of the switch module **140**, one for each phase.

[0043] 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 **120**.

[0044] 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 **120** being in the OFF state and the other endpoint corresponds to the switch apparatus **120** being in the ON state. In another example, the operating interface **190** may be a push-button interface or an electronic interface.

[0045] The driving assembly **195** is any type of assembly that is capable of translating the operation of the operating interface **190** to the movable contact **142**. For example, the driving assembly **195** may include a mechanical linkage, a shaft, gears, motors, plungers, springs, actuators, or a combination of such devices.

[0046] The switching system **110** also may include additional components that are not shown. For example, the switching system **110** a fuse holding assembly. 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.

[0047] FIGS. **2**A and **2**B are side views of a switch apparatus **220**. The switch apparatus **220** includes an arc chute **250** that dissipates arcs that may form when the switch apparatus **220** is opened. FIGS. **2**C and **2**D show the arc chute **250**.

[0048] Referring to FIGS. **2**A and **2**B, the switch module **240** includes a stationary contact **244** and a movable contact **242** that moves relative to the stationary contact **244** to open or close the switch module **240**. When the switch module **240** is closed (FIG. **2**A), the movable contact **242** is in physical contact with the stationary contact **244**. When the switch module **240** is open (FIG. **2**B), the movable contact **242** is not in physical contact with the stationary contact **244**. To open the switch module **240**, the movable contact **242** is separated from the stationary contact **244**. For example, the movable contact **242** may be translated along a linear path in the −Y direction or rotated along an arc **245** (FIG. **2**A).

[0049] Referring also to FIG. **2**C, which is a front view of the arc chute **250** in the X-Z plane, and FIG. **2**D, which is a cross sectional side view of the arc chute **250** in the Y-Z plane, the arc chute **250** includes a housing **252** and a plurality of plates **254-1** to **254-9** (collectively referred to as the plates **254**) in the housing **252**. The housing **252** extends in the Z direction from a first end **251** to a second end **253**. The first end **251** of the housing **252** is mounted on the stationary contact **244**. The housing **252** includes a first sidewall **255***a* and a second sidewall **255***b*. The first and second sidewalls **255***a*, **255***b* are parallel to each other and extend generally in the Y-Z plane. The housing **252** may be made of an electrically insulating material, such as, for example, a polymeric material.

[0050] The plates **254** are mounted in the housing **252** and are electrically insulated from each other. The plates **254** are mounted in the housing **252** by mounting features (not shown) that mechanically secure the plates **254** to an inner wall **256***a* of the first sidewall **255***a* and to an inner wall **256***b* of the second sidewall **255***b*. The mounting features may be openings in the inner walls **256***a*, **256***b* (or openings on mounting plates that are on the inner walls **256***a*, **256***b*) that accept corresponding features (for example, tabs or posts) on the plates **254**. In some implementations, ablative material inserts **270***a*, **270***b* include the mounting features.

[0051] In the example of FIGS. **2**C and **2**D, each plate **254** extends in the X-Y plane. The plates **254** are substantially parallel to each other and perpendicular to the sidewalls **255***a*, **255***b*. The plates **254** may be made of an electrically conductive material, for example, a ferrous metal such as steel. The plates **254** are electrically insulated from each other by air and/or another insulating material disposed between the plates **254**. In the example of FIGS. **2**C and **2**D, the plates **254** are separated by gaps in the Z direction.

[0052] Other implementations are possible. For example, the plates **254** may be angled relative to the X-Y plane and are not necessarily parallel to each other. Moreover, the plates **254** are not necessarily rectangular in shape. For example, the plates **254** may include cut portions or notches to encourage the arc to enter and remain in the chute **250**.

[0053] The arc runner **260** is integrally attached to the inner wall **256***a* and the inner wall **256***b*. Referring also to FIG. **2**E, which shows the arc runner **260**, the arc runner **260** includes a base portion **262** that extends from the inner wall **256***a* to the inner wall **256***b*, and a tab **264** extends away from the base portion **262** in the −Z direction. The base portion **262** is planar, plate-like structure. The arc runner **260** is a single-piece structure, and the base portion **262** and the tab **264** are permanently attached to each other. For example, the arc runner **260** may be formed as a single metal part, or the tab **264** may be a bar, block, or sheet that is welded or brazed to the base portion **262**. The tab **264** is a ferrous material such as, for example, steel. The base portion **262** may be the same material as the tab **264**.

[0054] The arc runner **260** is integral with the housing **252** such that the arc runner **260** is part of the arc chute **250**. For

example, the base portion **262** may be permanently attached to the inner walls **256***a*, **256***b* with, for example, an adhesive, mechanical fastener, or surface feature. An example of a surface feature is a slot in each of the inner walls **256***a*, **256***b* that receive and hold the base **262** in the housing **252**. In some implementations, the housing **252** and the arc runner **260** are extruded or molded as a single piece. The arc runner **260** is close to the first end **251** of the housing.

[0055] Referring also to FIG. **2**F, which is a perspective view of the arc guide **280**, the arc guide **280** includes a guide plate **282** and a retention plate **284**. The retention plate **284** extends from the guide plate **282** at an angle **283**. The angle **283** may be greater than 90 degrees (°) and less than 180°. The guide plate **282** is secured to the inner wall **256***a* and the inner wall **256***b* with mounting features. For example, the guide plate **282** may include protrusions that are held in corresponding openings in the inner wall **256***a* and the inner wall **256***b*.

[0056] When installed in the housing **259**, the arc guide **280** extends between the inner wall **256***a* and the inner wall **256***b* with the retention plate **284** oriented toward the second end **253**. The arc guide **280** is near the second end **253** of the housing **252**. The plates **254** are between the arc guide **280** and the arc runner **260**.

[0057] The ablative material insert **270***a* is along the inner wall **256***a*, and the ablative material insert **270***b* is along the inner wall **256***b*. The plates **254**, the arc runner **260**, and the guide plate **282** may be attached to the inserts **270***a*, **270***b* to form a sub-assembly that is mounted in the housing **259** between the inner walls **256***a*, **256***b*. The insert **270***a* and the insert **270***b* may be held to the respective inner wall **256***a* and **256***b* by a tight fit or an adhesive. The ablative material inserts **270***a* and **270***b* may be sheets, masks, foams, or plates of any ablative material. The ablative material may be any type of material that erodes and/or vaporizes in the presence of heat. The erosion and/or vaporization may produce a layer of gas and/or material that deflects and/or absorbs heat to reduce the temperature of the arc. Examples of ablative material that may be used for the inserts **270***a*, **270***b* include, without limitation, cellulous filled melamine (CFM), fish paper, or a vulcanized fiber material.

[0058] In operational use of the switch apparatus **220**, the arc chute **250** is mounted to the stationary contact **244** with the tab **264** of the arc runner **260** oriented toward the path of the movable contact **242** and toward the likely location of the arc. For example, the tab **264** may be in physical contact with the stationary contact **244** and facing toward the movable contact **242**.

[0059] In operational use of the switch module **240**, electrical current may flow in the switch module **240** when the module **240** is closed (FIG. **2**A). To open the switch module **240**, the movable contact **242** is separated from the stationary contact **244**. If current is flowing in the switch module **240** when the movable contact **242** separates from the stationary contact **244**, an arc may form in the open space between the separated contacts **242** and **244**. The tab **264** and the arc runner **260** include a ferrous material that draws the arc into the arc chute **250** through magnetic force. The arc enters the arc chute **250** and dissipates through interactions with the plates **254** and the ablative material inserts **270***a*, **270***b*. The arc is also retained in the arc chute **250** by the arc guide **280**. Retaining the arc in the arc chute **250** provides additional time for the arc to cool, dissipate, and/or be quenched by the ablative material inserts **270***a*, **270***b*. In this way, the configuration of the arc chute **250** reduces or eliminates damage that could be caused by the arc, thereby improving the overall performance of the switch module **240**.

[0060] FIG. **3**A is a front view of an arc chute **350**. FIG. **3**B is a cross-sectional view of the arc chute **350**. The arc chute **350** is another example of an arc chute that may be used in the switch apparatus **120** (FIG. **1**). The arc chute **350** includes a housing **352** that includes a first portion **355***a* and a second portion **355***b*. The first and second portions **355***a* and **355***b* are held together by fasteners **358**. The fasteners **348** may be, for example, bolts or screws. The first and second portions **355***a* and **355***b* may be molded housings made of a polymeric material. When assembled, the housing **352** extends from a first end **351** to a second end **353**.

[0061] The arc chute **350** includes a first ablative insert **370***a* on an interior wall **356***a* of the portion **355***a*, and a second ablative insert **370***b* on an interior wall **356***b* of the portion **355***b*. The arc chute **350** also includes an arc runner **360**, an arc guide **380**, and a plurality of plates **354** between the arc runner **360** and the arc guide **380**. For simplicity only one of the plates **354** is labeled. Each plate **354** is mounted to the interior wall **356***a* and the interior wall **356***b* and extends between the interior walls **356***a* and **356***b*. The plates **354**, the arc runner **360**, and the arc guide **380** may be made of a ferrous material, such as, for example, steel or an iron alloy.

[0062] The arc runner **360** includes a base portion **362** and a tab **364** that extends from the base portion **362**. The base portion **362** extends in a different plane than the tab **364**. The base portion **362** is mounted to the interior walls **356***a* and **356***b* and extends between the interior walls **356***a* and **356***b*.

[0063] The arc guide **380** includes a guide plate **382** and a retention portion **384** that extends at an angle from the guide plate **382**. The guide plate **382** is mounted to the interior walls **356***a* and **356***b* and extends between the interior walls **356***a* and **356***b*. The retention portion **384** extends toward the second end **353**.

[0064] Referring also to FIG. **3**C, the plates **354** are planar structures that extend from a bottom end **357** to a top end **359**. The top end **359** includes a notch or cut portion **365**. The profile of the notch or cut portion **365** may be different for each plate **354**. The cut portions **365** help to guide the arc into the arc chute **350**. As shown in FIG. **3**B, the plates **354** are separated from each other, from the arc runner **360**, and from the arc guide **380**. The plates **354** are arranged in a spaced apart manner that follows a path **366** in the Y-Z plane. The plates **354** are not parallel with the X, Y, or Z axis and may be angled at different angles relative to one of the axis. The base portion **362** of the arc runner **360** and the guide plate **382** of the arc guide **380** are also not parallel with the X, Y, or Z axis.

[0065] The arc chute **350** also includes an exterior mounting assembly **389**. The exterior mounting assembly **389** may be, for example, a bracket or block that attaches to the portions **355***a* and/or **355***b* and an electrical contact of a switching apparatus (such as the switch apparatus **120** of FIG. **1**). For example, the exterior mounting assembly **389** may be used to attach the arc chute **350** to the stationary contact **144**.

[0066] FIG. **4** is a perspective exploded view of an arc chute **450**. FIG. **5** is a perspective view of the arc chute **450** assembled and mounted to a switch apparatus **520***a* in a

switching system **510**. The arc chute **450** may be used with other switching systems, such as, for example, the switching system **110** of FIG. **1**.

[0067] The arc chute **450** includes a first housing portion **455***a* and a second housing portion **455***b* held together by bolts **458** to form a housing **452** (FIG. **5**). The first and second housing portions **455***a* and **455***b* are made of an electrically insulating material, such as, for example, a polymeric material. The housing **452** extends from a first end **451** to a second end **453**.

[0068] The arc chute **450** also includes an arc runner **460**, an arc guide **480**, and a plurality of plates **454** (only one of which is labeled in FIG. **4**). Each plate **454** includes a planar portion that extends from a first end **457** to a second end **459** and a cut portion **465** at the second end **459**. Each plate **454** may have a cut portion **465** with a different profile. Each plate **454** also includes mounting features **467** that extend generally the same plane as the planar portion of the plate **454**. The mounting features **467** are tabs in the example of FIG. **4**, but other mounting features may be used. For example, the mounting features **467** may be posts.

[0069] The arc runner **460** includes a base portion **462** and a tab **464** that extends from the base portion **462**. In the example of FIG. **4**, the base portion **462** extends in the X-Y plane, and the tab extends in the-Z direction. The arc guide **480** includes a guide plate **482** and a retention portion **484** that extends at an angle from the guide plate **482**. The guide plate **482** also includes mounting features **485** that extend in generally the same plane as the guide plate **482**.

[0070] The arc chute **450** includes a first ablative material insert **470***a* and a second ablative material insert **470***b*. Each ablative material insert **470***a*, **470***b* is configured to be placed against a respective interior wall **456***a*, **456***b* of the housing portion **455***a*, **455***b*. The ablative material inserts **470***a*, **470***b* are plates or sheets of ablative material that extend in the same plane of the interior walls **456***a*, **456***b* (generally the Y-Z plane in FIG. **4**). The ablative material inserts **470***a*, **470***b* include openings **473**, only one of which is labeled in FIG. **4**. The openings **473** are arranged in the same pattern on the insert **470***a* and the insert **470***b*.

[0071] Each opening **473** accepts one of the mounting features **467** or one of the mounting features **485**. When the ablative material inserts **470***a*, **470***b* are attached to respective interior walls **456***a*, **456***b* and when the openings **473** accept the mounting features **467** and **485**, the plates **454** and the arc guide **480** are mounted in the housing **452**. When mounted in the housing, the plates **454** and the arc guide **480** extend along the X direction between the interior wall **465***a* and the interior wall **465***b*, with the arc guide at the end **453** of the housing **452** and the arc runner **460** at the end **451** of the housing **452**. The plates **454**, the arc runner **460**, and the arc guide **480** may be made of a ferrous material, such as, for example, steel or an iron alloy.

[0072] Referring to FIG. **5**, the switching system **510** includes two switch modules: a switch module **540***a* and a switch module **540***b* mounted on a support **511**. Each switch module **540***a*, **540***b* includes a respective stationary contact **544***a*, **544***b* and a respective movable contact **542***a*, **542***b*. The arc chute **450** is mounted to the stationary contact **544***a* by attaching a mounting block **489** to the stationary contact **544***a*. When mounted to the stationary contact **544***a*, the arc chute **450** is oriented such that the arc runner **460** and the tab **464** face the movable contact **542***b*. This positioning helps to ensure that the arc enters the arc chute **450**.

[0073] These and other implementations are within the scope of the claims.

What is claimed is:

1. An arc chute apparatus comprising:

a housing comprising a first sidewall, a second sidewall, and an arc runner, the arc runner comprising: a base portion integral with the housing and extending between the first sidewall and the second sidewall; and a tab that extends from the base portion and is configured to be oriented toward an electrical contact of a switching device, wherein the arc runner comprises a ferrous material;

an arc guide between the first sidewall and the second sidewall;

an ablative insert in the housing; and

mounting features configured to hold a plurality of ferrous plates in a spaced apart arrangement in the housing between the first sidewall and the second sidewall and between the arc guide and the arc runner.

2. The arc chute apparatus of claim **1**, wherein the base portion is planar and the tab extends in a different plane than the base portion.

3. The arc chute apparatus of claim **2**, wherein the tab extends perpendicularly from the base portion.

4. The arc chute apparatus of claim **1**, wherein the arc guide comprises: a guide plate that extends between the first sidewall and the second sidewall, and a retention portion.

5. The arc chute apparatus of claim **1**, wherein the ablative insert comprises a first ablative insert adjacent to the first sidewall, and a second ablative insert adjacent to the second sidewall.

6. The arc chute apparatus of claim **5**, wherein the mounting features are openings in the first ablative inert and openings in the second ablative insert.

7. The arc chute apparatus of claim **1**, wherein the mounting features comprise: a first mounting plate on an inner side of the first sidewall, a second mounting plate on an inner side of the second sidewall.

8. The arc chute apparatus of claim **7**, wherein the first mounting plate and the second mounting plate are identical and include a plurality of openings each configured to receive a mounting portion of a ferrous plate or a mounting portion of the arc guide.

9. A switching device comprising:

a first electrical contact;

a second electrical contact configured to move relative to the first electrical contact; and

an arc chute apparatus comprising:

a housing comprising a first sidewall, a second sidewall, and an arc runner, the arc runner comprising: a base portion integral with the housing and extending between the first sidewall and the second sidewall; and a tab that extends from the base portion and is configured to be oriented toward one or more of the first electrical contact and the second electrical contact, wherein the arc runner comprises a ferrous material.

10. The switching device of claim **9**, further comprising mounting features configured to hold a plurality of ferrous plates between the first sidewall and the second sidewall.

11. The switching device of claim **10**, wherein the arc chute apparatus further comprises an arc guide, and mounting features configured to hold the plurality of ferrous plates between the arc guide and the arc runner.

12. The switching device of claim **9**, wherein the arc chute apparatus is configured to be mounted to the first electrical contact.

13. The switching device of claim **9**, wherein the arc chute apparatus further comprises an ablative insert in the housing.

14. The switching device of claim **13**, wherein the ablative insert comprises a first ablative insert adjacent to the first sidewall, and a second ablative insert adjacent to the second sidewall.

15. A housing assembly for an arc chute, the housing assembly comprising:

a first sidewall;

a second sidewall;

interior mounting features configured to hold a plurality of ferrous plates between an interior side of the first sidewall and an interior side of the second sidewall; and

an arc runner comprising: a base portion and a tab that extends from the base portion, wherein an exterior of the housing assembly is configured for mounting to an electrical contact of a switching apparatus, the base portion is integrally attached to the interior side of the first sidewall and the interior side of the second sidewall, the base portion and the tab comprise a ferrous material, and the tab is configured to be positioned toward an arc generating location of the switching apparatus.

16. The housing assembly of claim **15**, further comprising an arc guide.

17. The housing assembly of claim **16**, further comprising an ablative insert.

18. The housing assembly of claim **17**, wherein the interior mounting features comprise openings in the ablative insert.

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