US 20250259809A1

(19) United States

(12) Patent Application Publication

Tesch et al.

(10) Pub. No.: US 2025/0259809 A1

(43) Pub. Date: Aug. 14, 2025

(54) MODULAR SWITCHGEAR SYSTEM

(71) Applicant: **G & W ELECTRIC COMPANY**, Bolingbrook, IL (US)

(72) Inventors: **William Tesch**, Montgomery, IL (US); **Nenad Uzelac**, St John, IN (US); **Kennedy Darko**, Bolingbrook, IL (US); **Andres Laso**, Chicago, IL (US)

(21) Appl. No.: **19/054,231**

(22) Filed: **Feb. 14, 2025**

Related U.S. Application Data

(60) Provisional application No. 63/553,473, filed on Feb. 14, 2024.

Publication Classification

(51) **Int. Cl.**

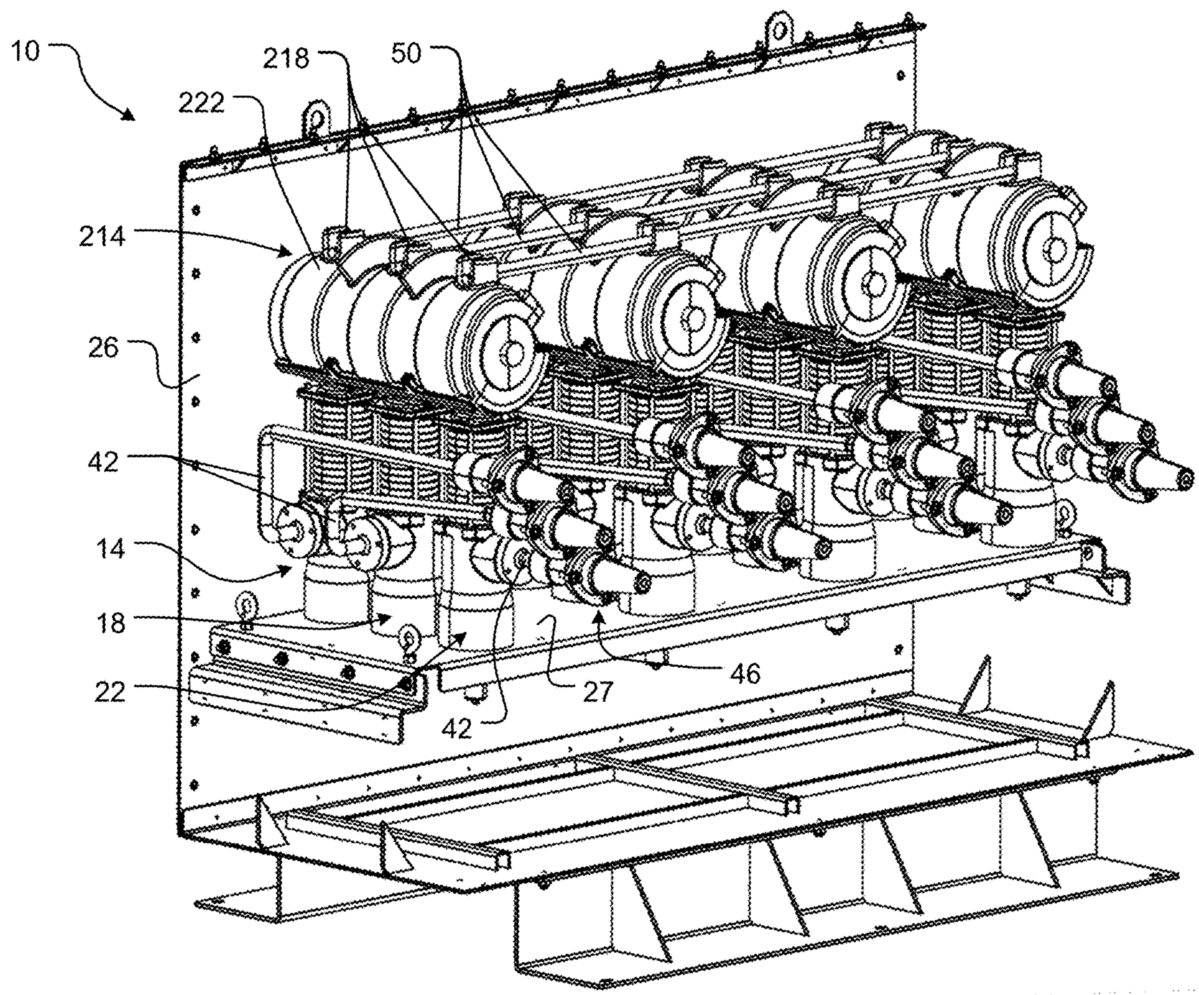
H01H 33/662 (2006.01)
H01H 33/66 (2006.01)
H01H 33/666 (2006.01)

(52) **U.S. Cl.**

CPC .. ***H01H 33/66207*** (2013.01); ***H01H 33/6606*** (2013.01); ***H01H 33/6661*** (2013.01)

(57) **ABSTRACT**

A switchgear system includes an enclosure containing atmospheric air and a loadbreak module disposed within the enclosure, the loadbreak module including a vacuum interrupter having a vacuum bottle enclosing a fixed contact and a movable contact, the movable contact movable along a first axis, and a sleeve surrounding the vacuum bottle. The loadbreak module further includes an interchange surrounded by a base housing, the interchange electrically connected to the movable contact, a first terminal surrounded by a first terminal housing, the first terminal electrically connected to the fixed contact, a second terminal electrically connected to the movable contact through the interchange, and a clamping assembly extending between the base housing and the first terminal housing. The vacuum interrupter is clamped between the first terminal housing and the base housing by the clamping assembly.



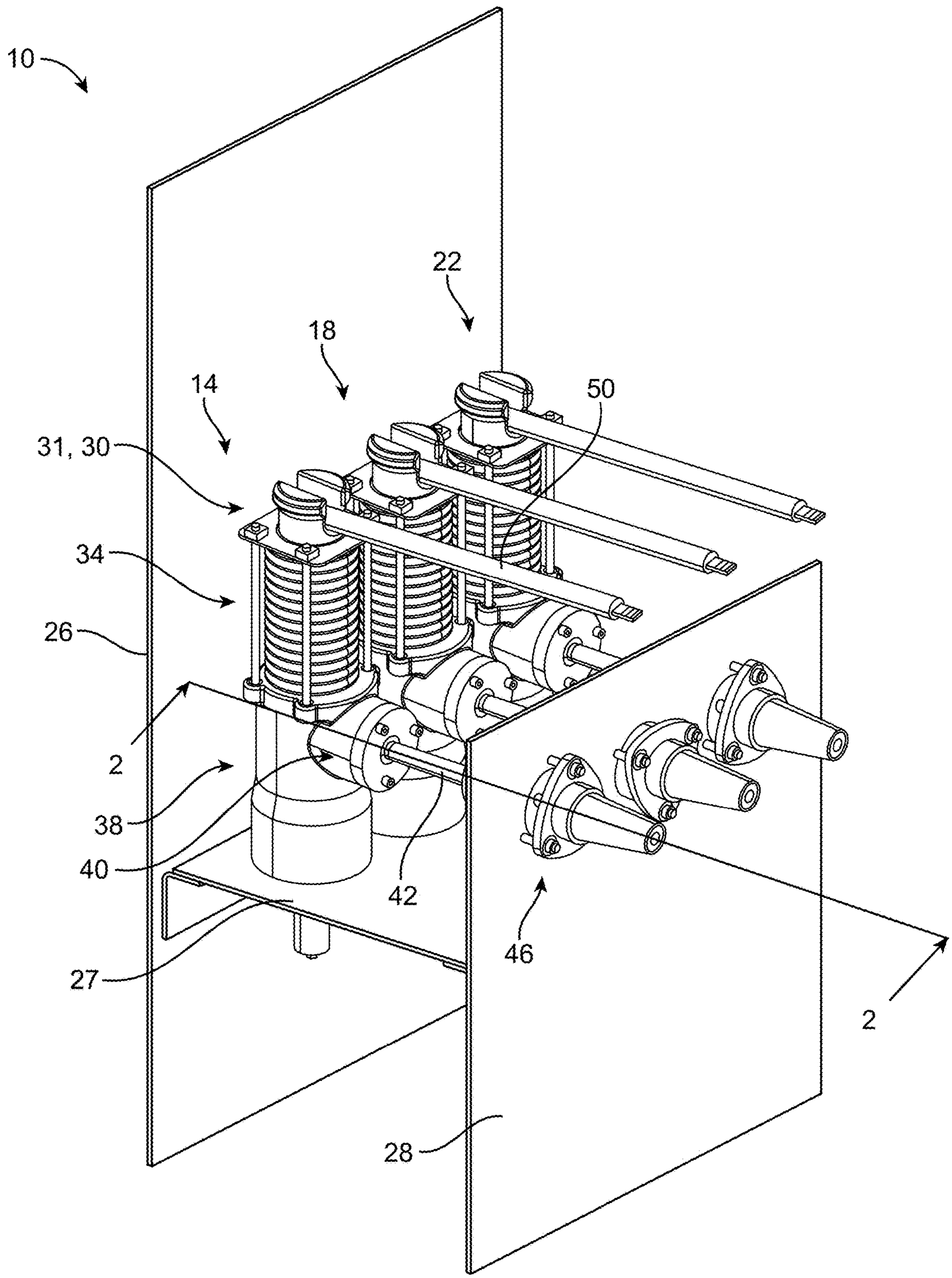


FIG. 1

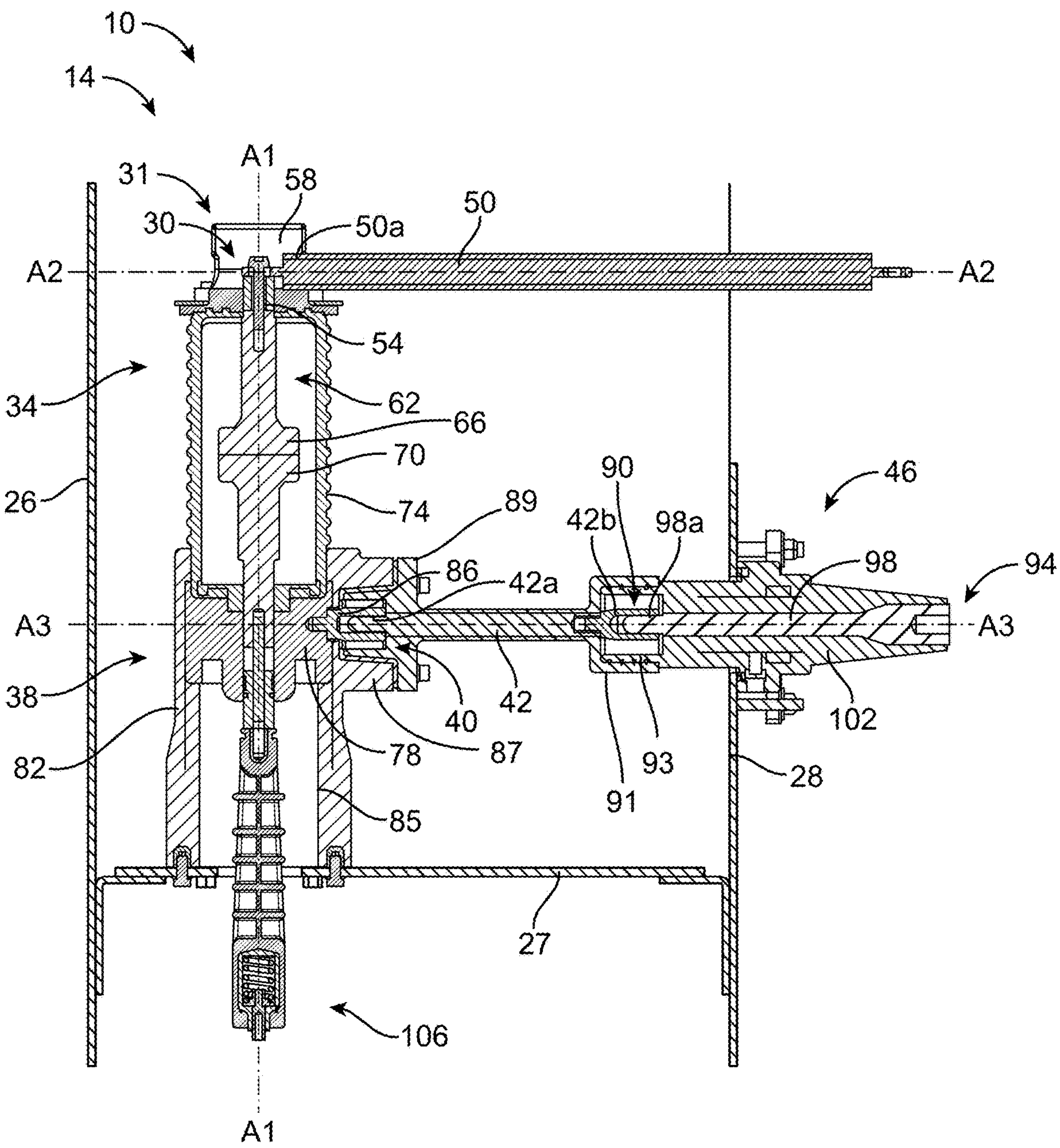

10
14
31
A1
58
30
50a
50
A2
A2
54
34
62
66
70
26
74
89
90
42b
98a
46
86
42a
98
94
A3
A3
38
40
42
102
82
78
87
91
93
28
85
27
106
A1

FIG. 2

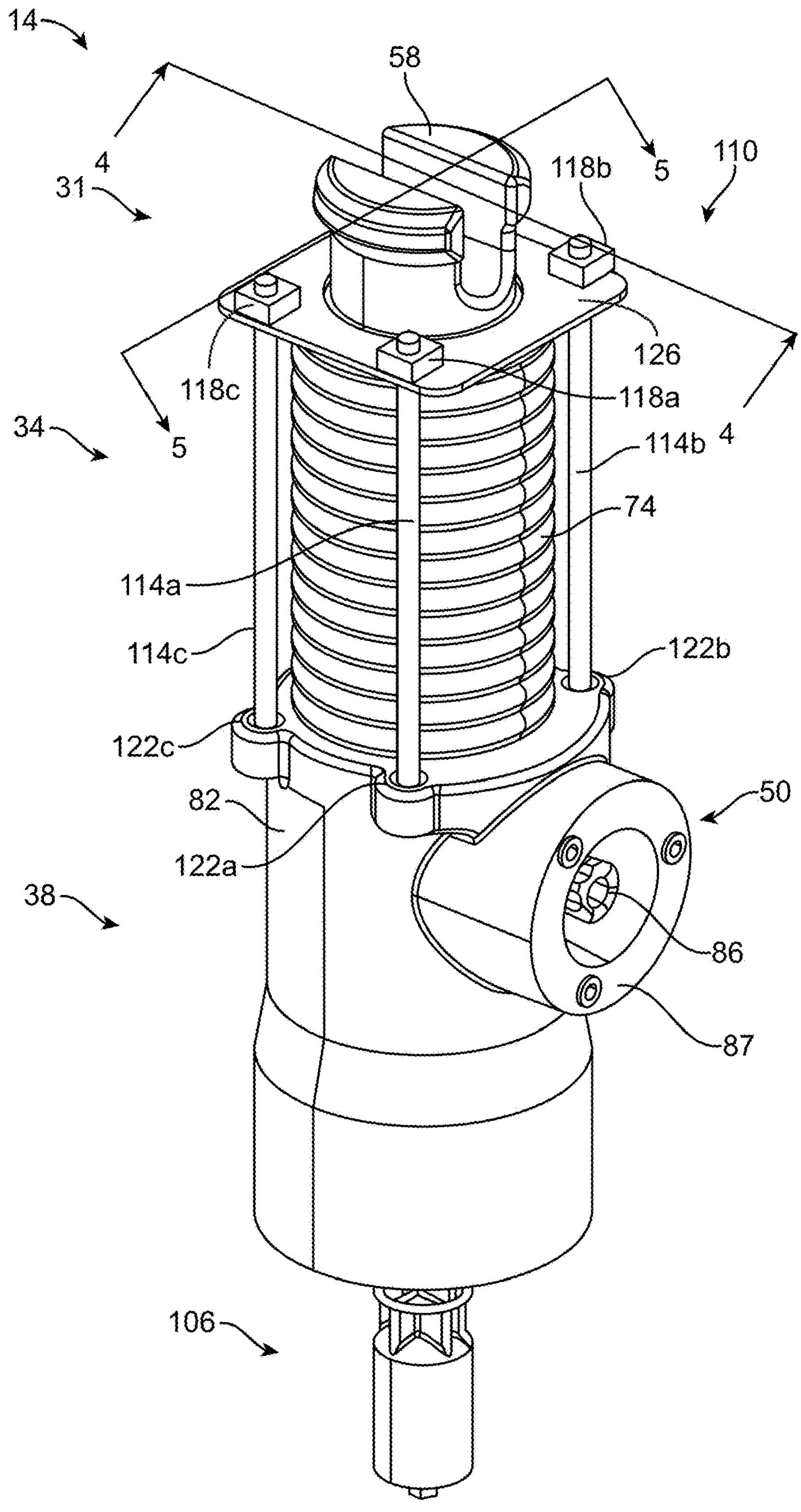

14
58
4
31
5
118b
110
126
118c
118a
34
5
114b
4
74
114a
114c
122b
122c
50
82
122a
86
38
87
106

FIG. 3

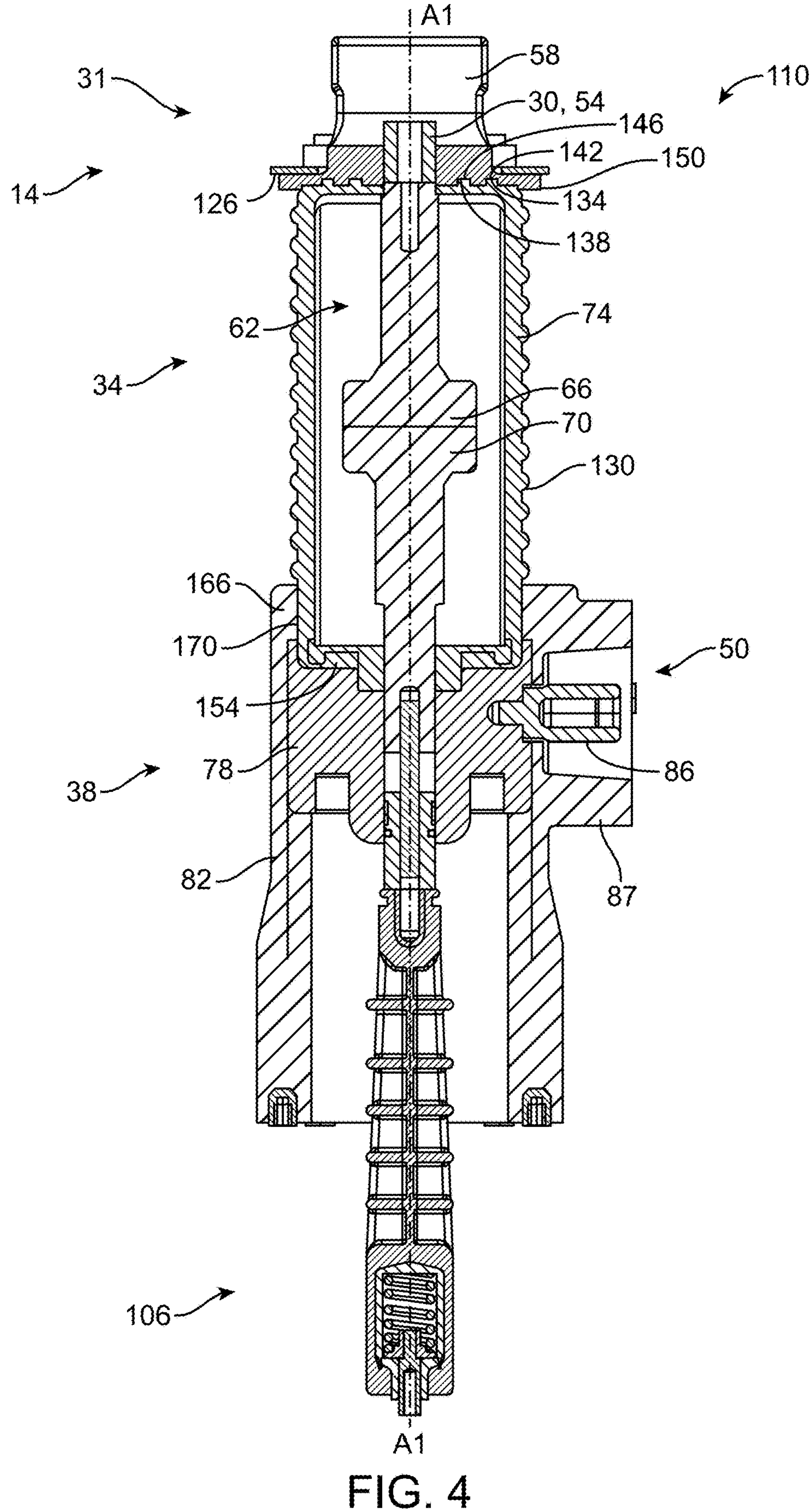

A1
58
31
110
30, 54
146
142
150
14
126
134
138
62
74
34
66
70
130
166
170
50
154
86
78
38
82
87
106
A1

FIG. 4

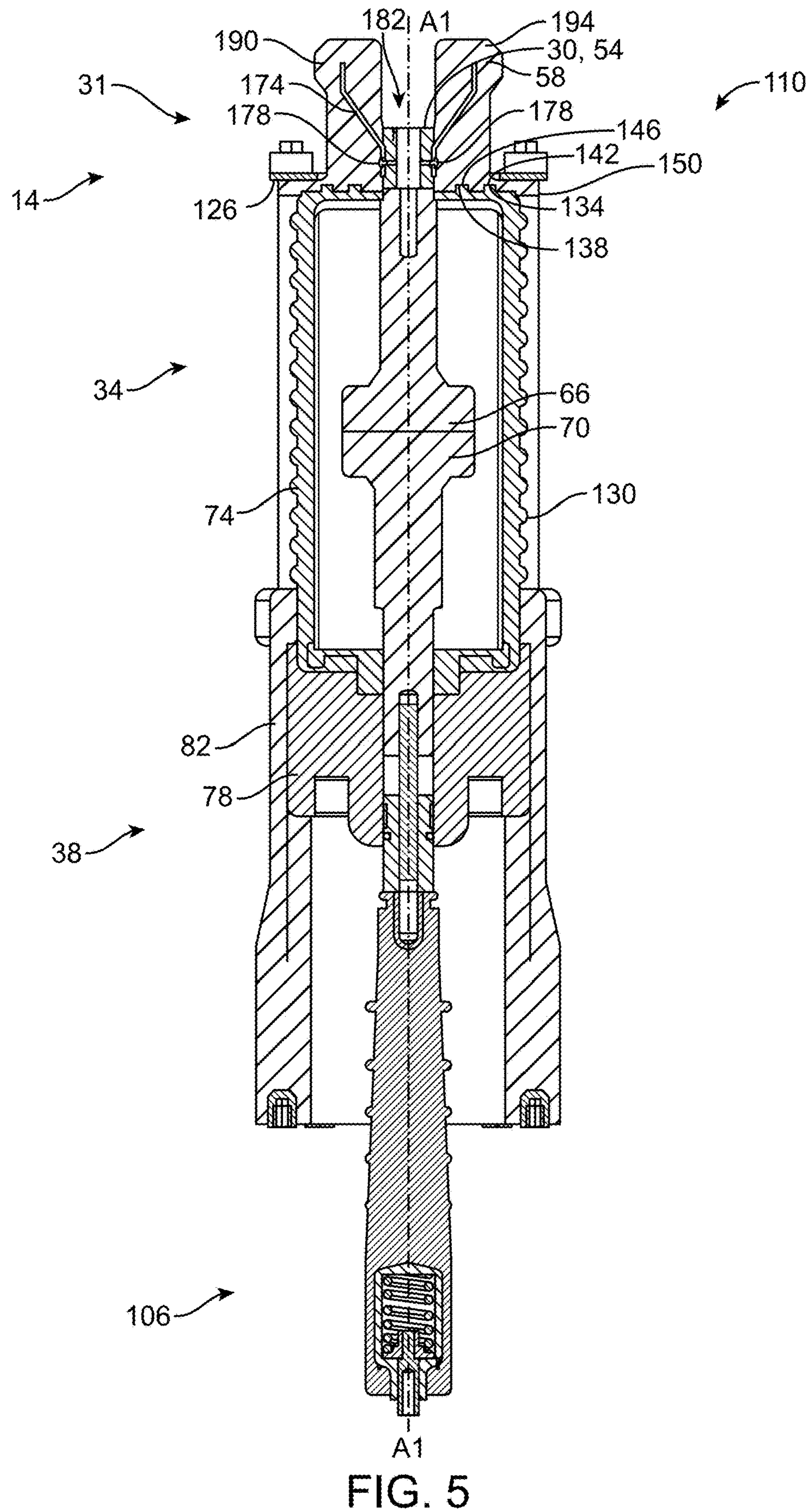

182
A1
194
190
30, 54
31
174
58
110
178
178
146
142
150
14
126
134
138
34
66
70
74
130
82
78
38
106
A1

FIG. 5

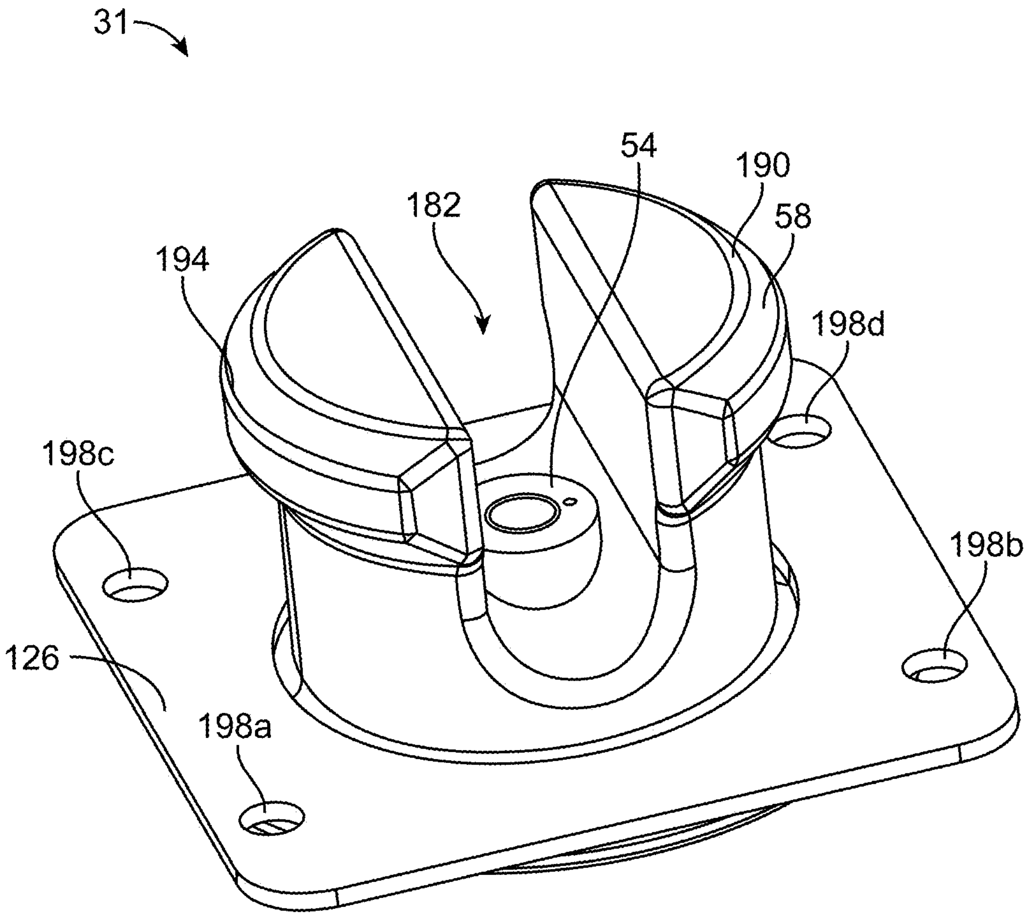


FIG. 6

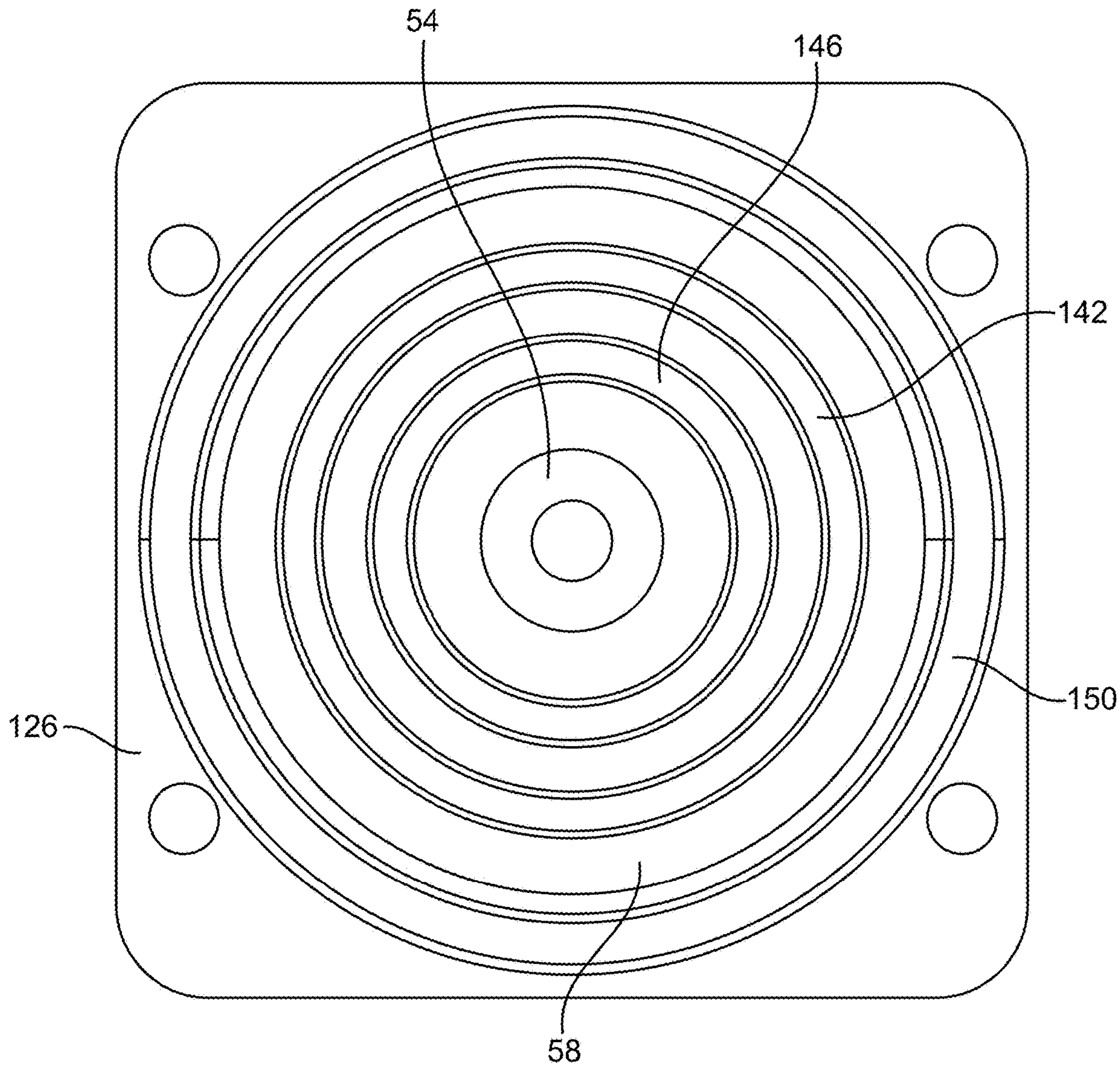


FIG. 7

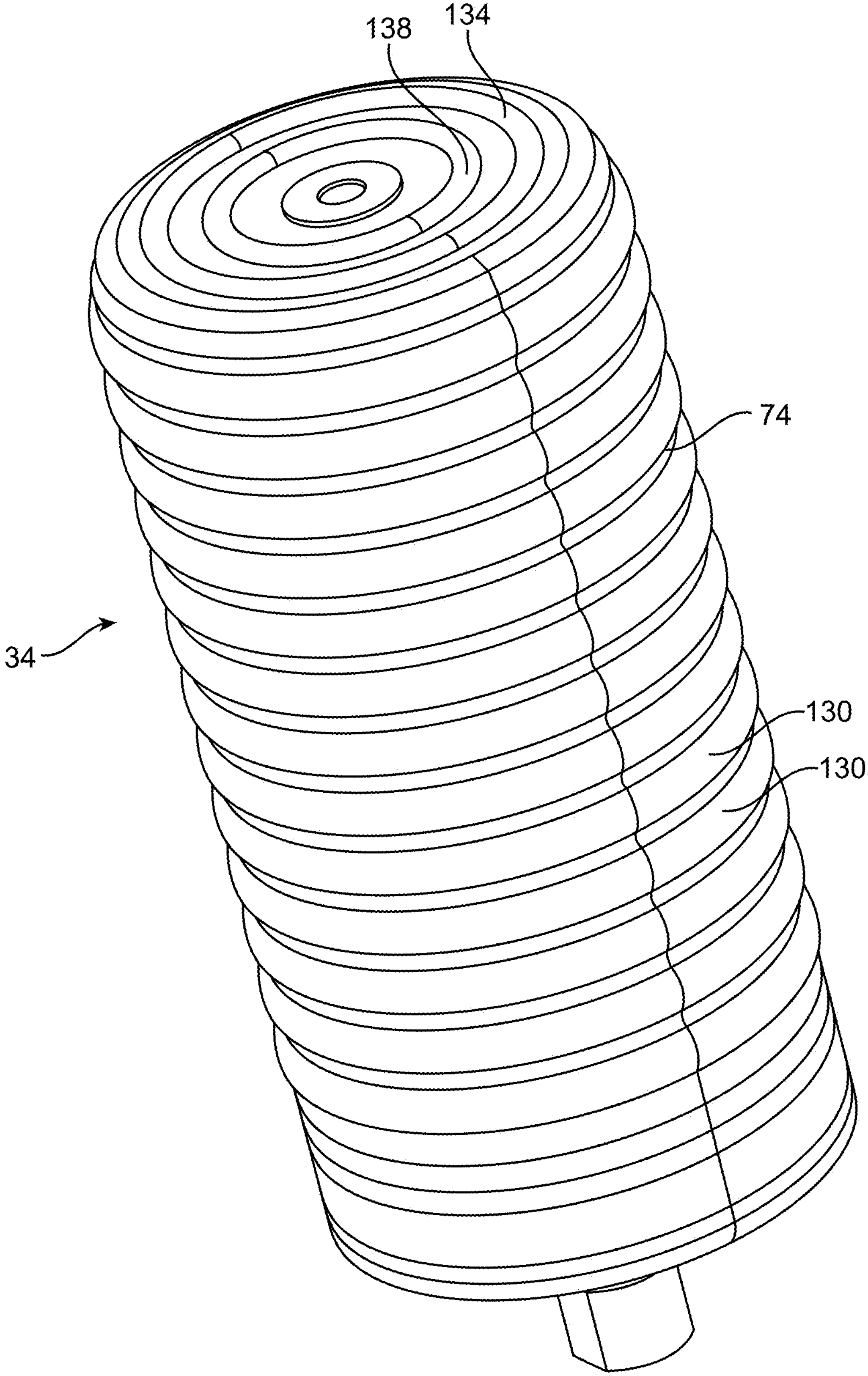


FIG. 8

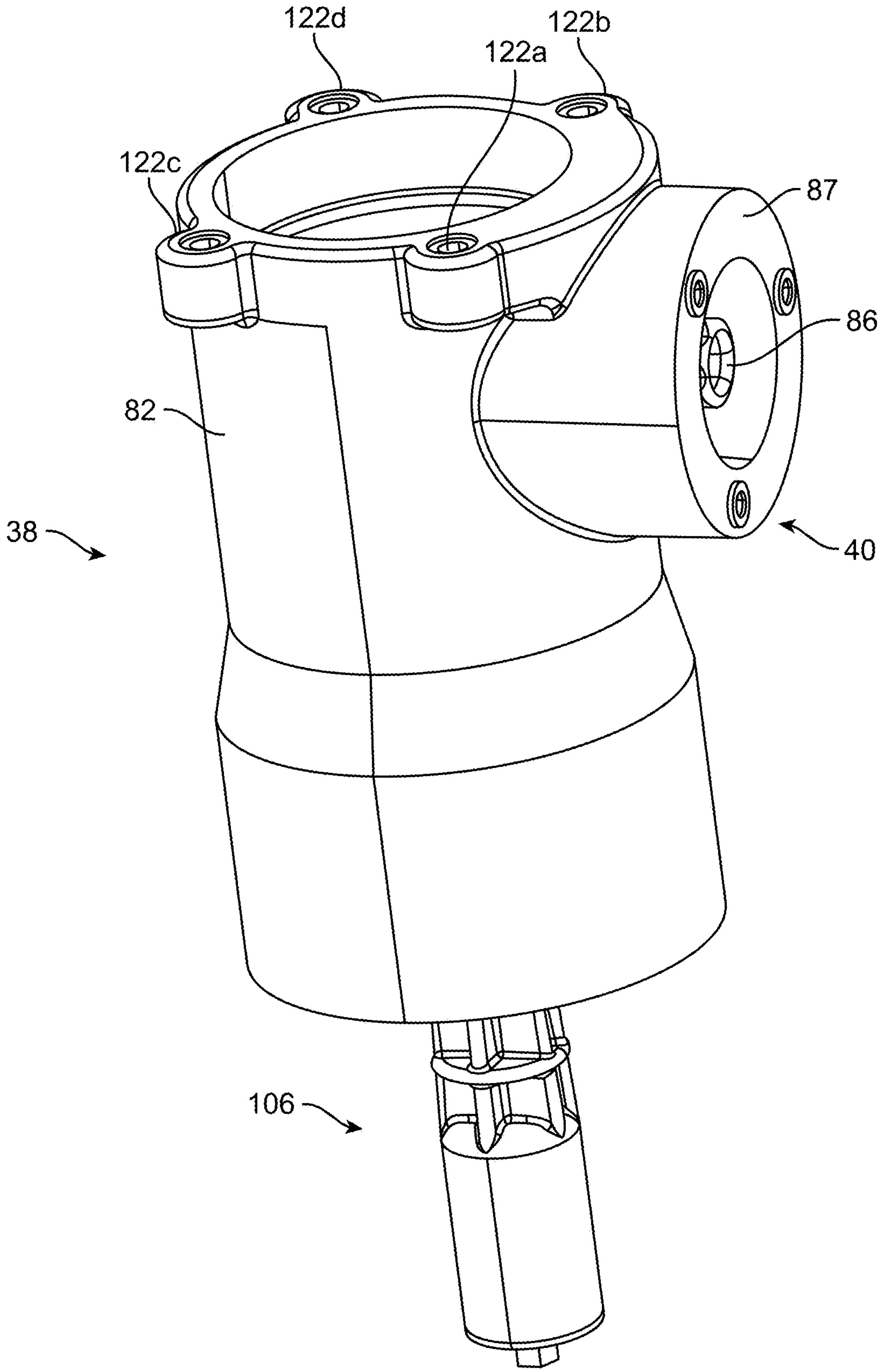
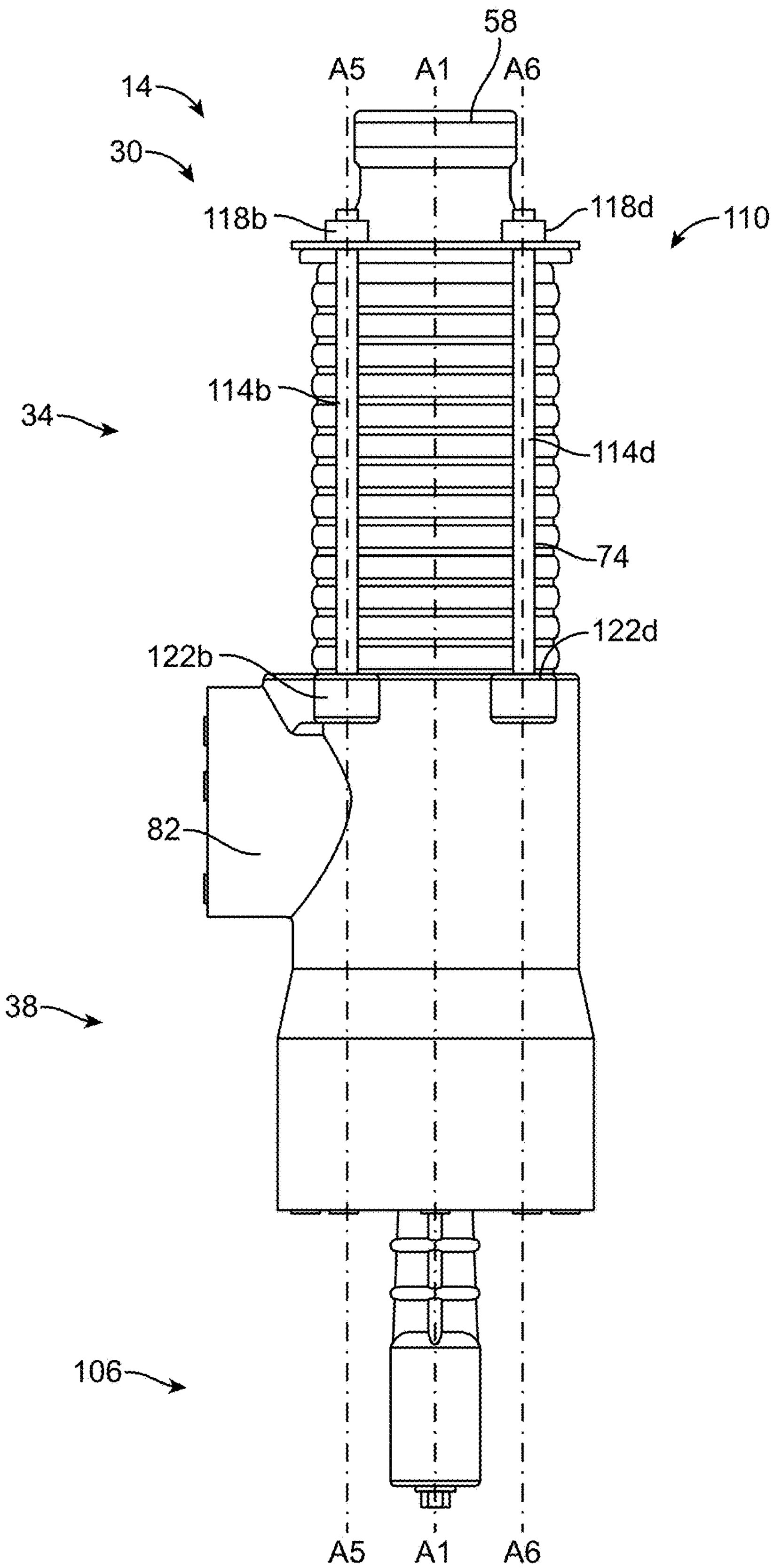


FIG. 9


58
A5
A1
A6
14
30
118b
118d
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74
122b
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106
A5
A1
A6

FIG. 10

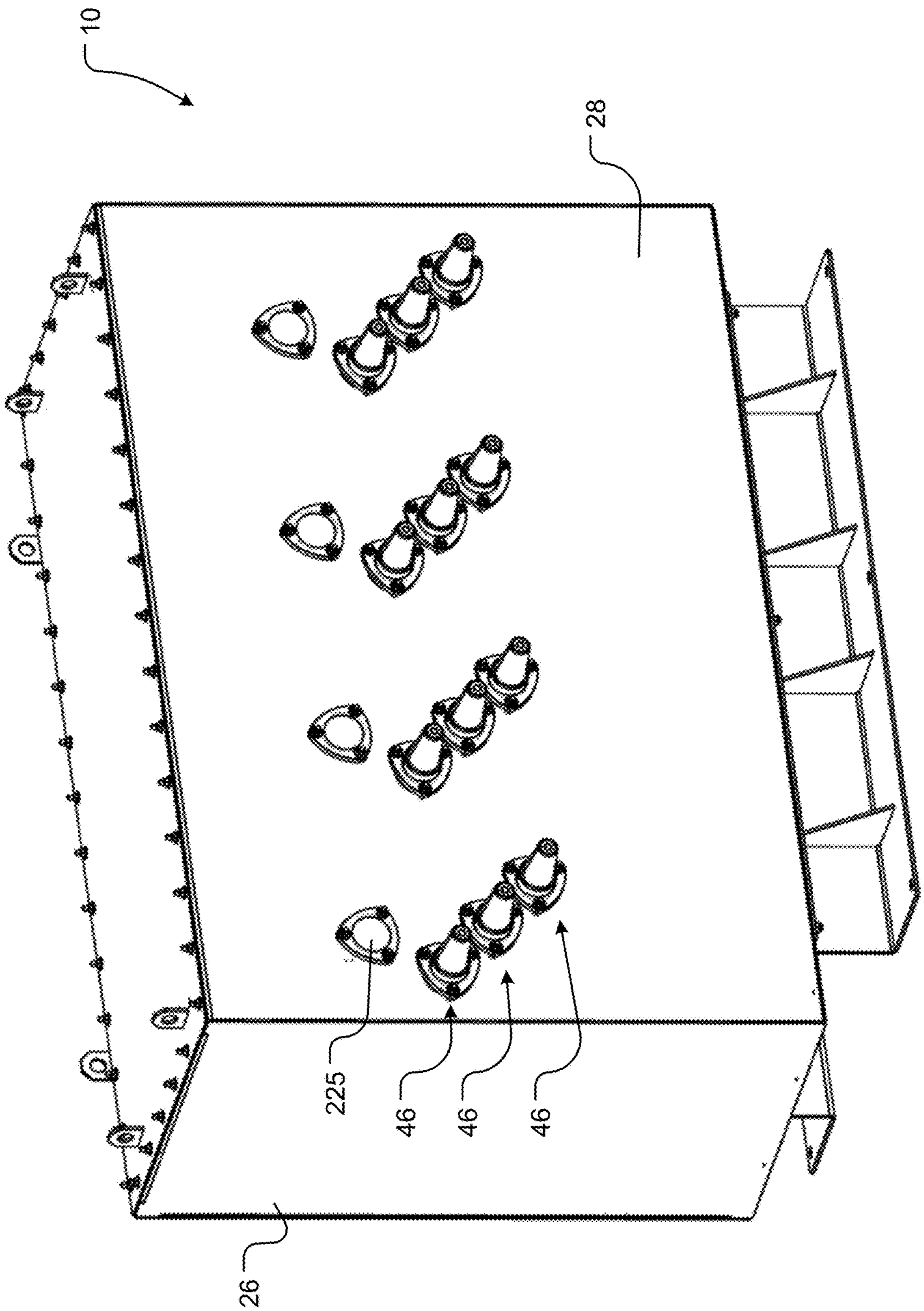


FIG. 11

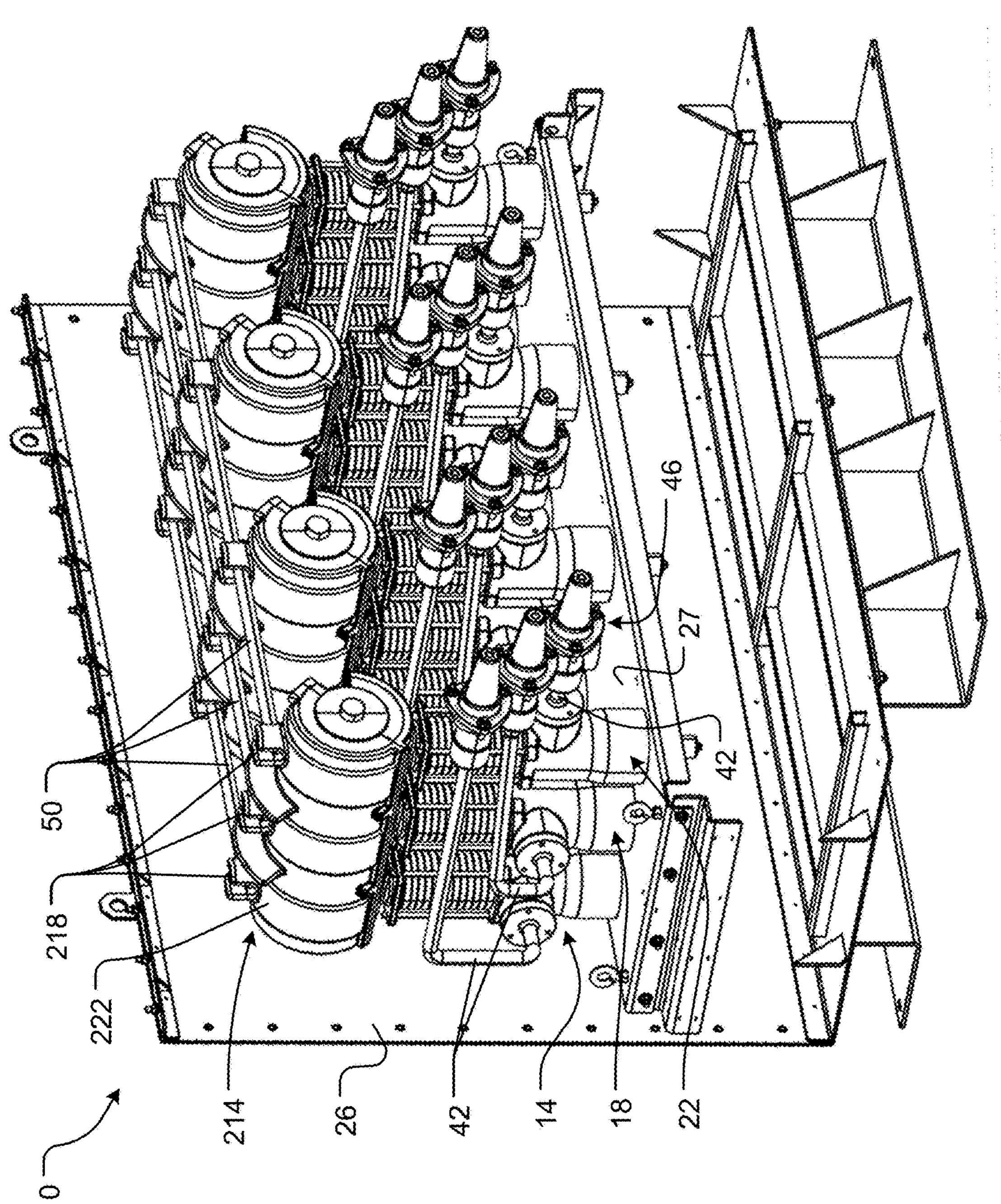
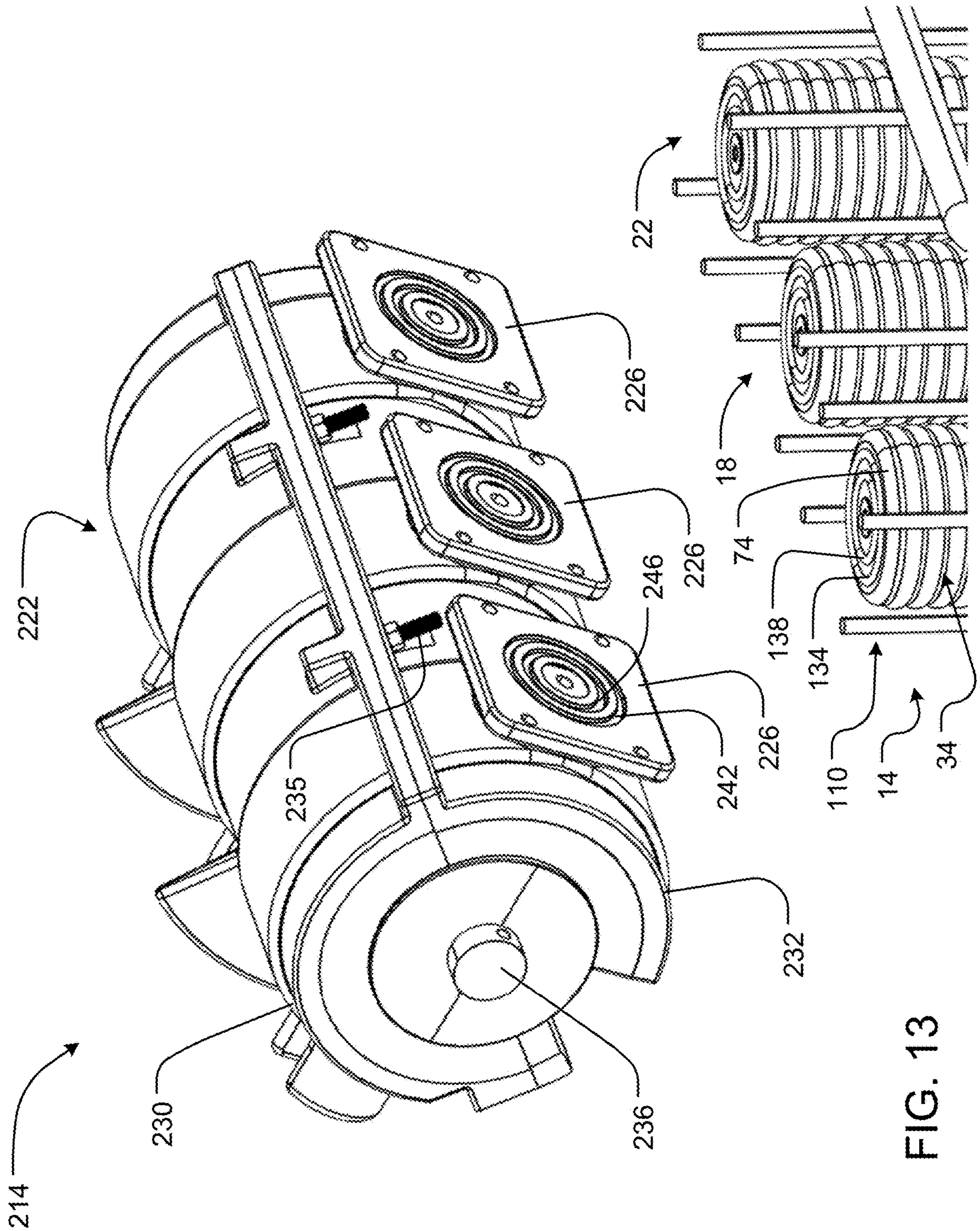


FIG. 12


214
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74
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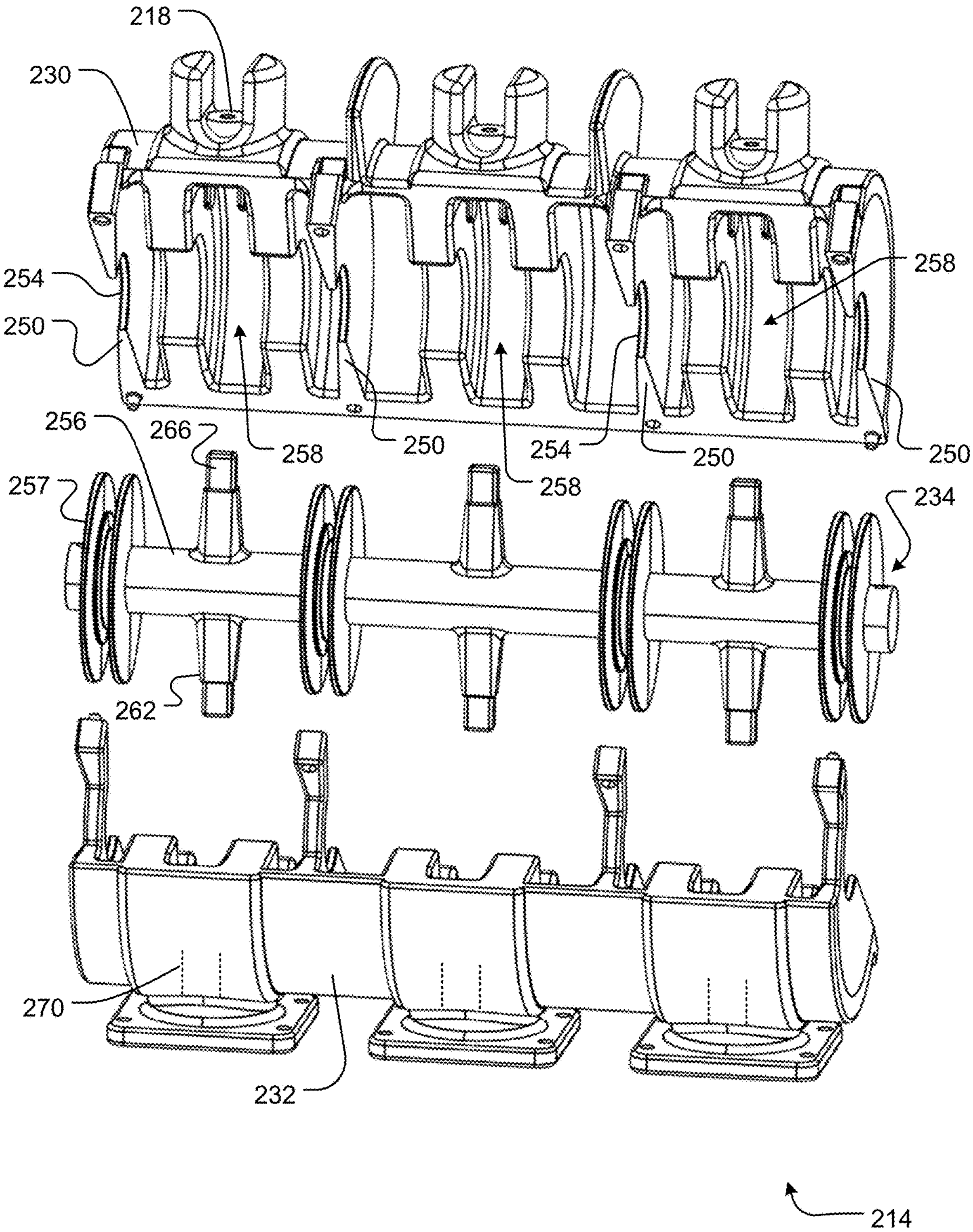
34

FIG. 13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262
270
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214

FIG. 14

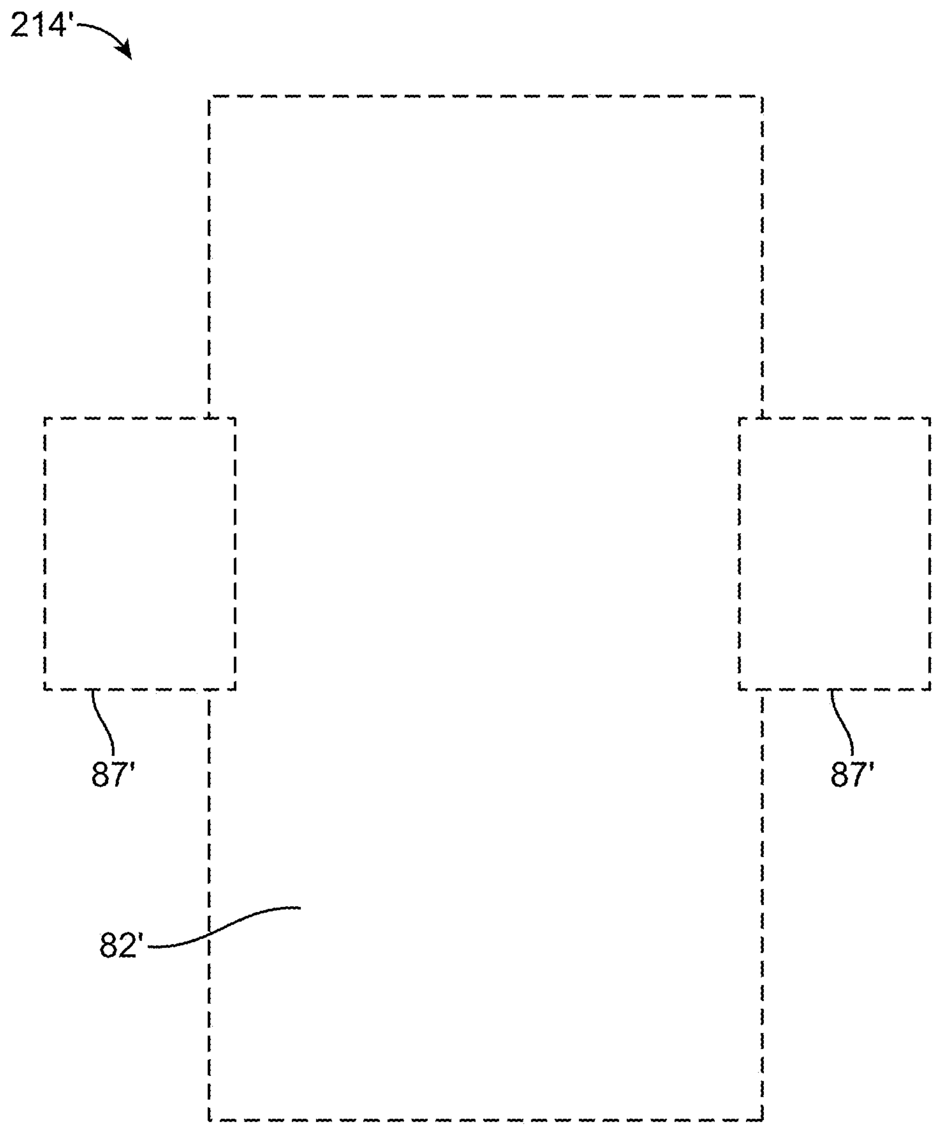

FIG. 15

MODULAR SWITCHGEAR SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 63/553,473, filed Feb. 14, 2024, the entire content of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to electrical switchgear, and, more particularly, to electrical switchgear with modular components.

BACKGROUND

[0003] Electrical switchgear is used to selectively open and close electrical connections in electrical power generation, transmission, and distribution systems. Gas-insulated electrical switchgear typically uses sulfur hexafluoride (SF6) contained within a tank to surround and insulate the high voltage components of the switchgear.

SUMMARY

[0004] SF6 is a potent greenhouse gas, and a need has been identified to reduce the use of SF6 for insulating electrical switchgear. Switchgear systems embodying aspects of the present disclosure may be entirely insulated with solid dielectric insulation, eliminating the need to surround the switchgear system with SF6.

[0005] Switchgear systems are often produced and used in many different configurations to suit a particular location, load requirement, wiring arrangement, and the like. Forming (e.g., molding) the components of a solid dielectric insulated switchgear system can be costly, particularly if multiple different molds are required to form different configurations of the system. Accordingly, the present disclosure provides, among other aspects, a modular switchgear system allowing one or more parts of the switchgear system to be used in different configurations of the switchgear system.

[0006] For example, in some aspects, the techniques described herein relate to a switchgear system including: an enclosure containing atmospheric air; and a loadbreak module disposed within the enclosure, the loadbreak module including: a vacuum interrupter having: a vacuum bottle enclosing a fixed contact and a movable contact, the movable contact movable along a first axis, and a sleeve surrounding the vacuum bottle, an interchange surrounded by a base housing, the interchange electrically connected to the movable contact, a first terminal surrounded by a first terminal housing, the first terminal electrically connected to the fixed contact, a second terminal electrically connected to the movable contact through the interchange, and a clamping assembly extending between the base housing and the first terminal housing, wherein the vacuum interrupter is operable to selectively break or establish an electrical pathway between the first terminal and the second terminal in response to movement of the movable contact relative to the fixed contact, wherein the vacuum interrupter is clamped between the first terminal housing and the base housing by the clamping assembly.

[0007] In some aspects, the techniques described herein relate to a switchgear system, further including a first conductor coupled to the first terminal and a second conductor coupled to the second terminal, and wherein the first conductor and the second conductor are each surrounded by insulation.

[0008] In some aspects, the techniques described herein relate to a switchgear system, wherein the sleeve includes an outer sealing ridge and an inner sealing ridge, both sealing ridges positioned on an end of the sleeve adjacent the first terminal.

[0009] In some aspects, the techniques described herein relate to a switchgear system, wherein the sleeve is made of a resilient insulating material overmolded on the vacuum bottle.

[0010] In some aspects, the techniques described herein relate to a switchgear system, wherein the sleeve is compressed between the first terminal housing and the base housing.

[0011] In some aspects, the techniques described herein relate to a switchgear system, wherein the sleeve includes a plurality of external circumferential ribs.

[0012] In some aspects, the techniques described herein relate to a switchgear system, wherein the first terminal housing is made of a molded solid dielectric material.

[0013] In some aspects, the techniques described herein relate to a switchgear system, wherein the base housing is made of a molded solid dielectric material.

[0014] In some aspects, the techniques described herein relate to a switchgear system, wherein the clamping assembly includes a plurality of clamping members extending between the first terminal housing and the base housing, the clamping members applying a force to the first terminal housing and to the base housing to compress the sleeve between the first terminal housing and the base housing to form a first dielectric seal between the first terminal housing and the sleeve and to form a second dielectric seal between the base housing and the sleeve.

[0015] In some aspects, the techniques described herein relate to a switchgear system, wherein each clamping member includes a threaded stud made of fiberglass.

[0016] In some aspects, the techniques described herein relate to a three-phase switchgear system including the switchgear system, wherein the loadbreak module is a first loadbreak module, and wherein the three-phase switchgear system further includes: a second loadbreak module identical to the first loadbreak module corresponding to a second phase of the three-phase switchgear system; and a third loadbreak module identical to the first loadbreak module corresponding to a third phase of the three-phase switchgear system, wherein the first, second, and third loadbreak modules are disposed within the enclosure.

[0017] In some aspects, the techniques described herein relate to a switchgear system, wherein a first terminal assembly includes the first terminal and the first terminal housing, and wherein the first terminal assembly is interchangeable with a disconnect switch assembly.

[0018] In some aspects, the techniques described herein relate to a switchgear system for a power distribution system, the switchgear system including: a vacuum interrupter including an insulating sleeve and a vacuum bottle surrounded by the sleeve, the vacuum bottle enclosing a fixed contact and a movable contact; a first terminal assembly including a first terminal configured to be electrically connected to the fixed contact and a first terminal housing made of a molded solid dielectric material, the first terminal surrounded by the first terminal housing; and a base assembly including a base housing made of a molded solid dielectric material, an interchange supported within the base housing and configured to be electrically connected to the movable contact, and a second terminal electrically connected to the interchange; wherein the vacuum interrupter is operable to selectively break or establish an electrical pathway between the first terminal and the second terminal in response to movement of the movable contact relative to the fixed contact; and a disconnect switch assembly configured to be modularly interchangeable with the first terminal assembly.

[0019] In some aspects, the techniques described herein relate to a switchgear system, wherein the first terminal assembly, the vacuum interrupter, and the second terminal assembly are clamped together to provide a first dielectric seal between the first terminal housing and the sleeve and to provide a second dielectric seal between the second terminal housing and the sleeve.

[0020] In some aspects, the techniques described herein relate to a switchgear system, wherein the disconnect switch assembly, the vacuum interrupter, and the second terminal assembly are clamped together to provide a first dielectric seal between the disconnect switch assembly and the sleeve and to provide a second dielectric seal between the second terminal housing and the sleeve.

[0021] In some aspects, the techniques described herein relate to a switchgear system, wherein the disconnect switch assembly includes a housing, a rotor supported by the housing and including a contact bar, a line terminal, and an input terminal opposite the line terminal, wherein the input terminal is configured to be electrically connected to the fixed contact, and wherein the rotor is rotatable between a closed position, in which the contact bar electrically connects the line terminal and the input terminal, and an open position, in which the line terminal and the input terminal are electrically disconnected.

[0022] In some aspects, the techniques described herein relate to a switchgear system, wherein the housing of the disconnect switch assembly includes a plurality of dividing walls each sandwiched between a pair of sheds extending from a shaft portion of the rotor.

[0023] In some aspects, the techniques described herein relate to a method of manufacturing a switchgear system, the method including: providing a vacuum bottle enclosing a fixed contact and a movable contact, the movable contact movable along a first axis; surrounding the vacuum bottle with a sleeve to form a vacuum interrupter assembly; providing a first terminal assembly including a first terminal surrounded by a first terminal housing, the first terminal electrically connected to the fixed contact; providing a base assembly including an interchange and a second terminal both electrically connected to the movable contact, the interchange and the second terminal both surrounded by a base housing; and clamping the vacuum interrupter assembly between the first terminal housing and the base housing to form a loadbreak module.

[0024] In some aspects, the techniques described herein relate to a method, wherein surrounding the vacuum bottle with the sleeve includes overmolding the sleeve on the vacuum bottle.

[0025] In some aspects, the techniques described herein relate to a method, wherein the sleeve is made of a resilient insulating material.

[0026] Other features and aspects of the disclosure will become apparent by consideration of the following detailed description and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] FIG. **1** is a perspective view of a switchgear system according to an embodiment of the present disclosure.

[0028] FIG. **2** is a cross-sectional view of the switchgear system of FIG. **1** taken along line **22** in FIG. **1**.

[0029] FIG. **3** is a perspective view of a loadbreak module of the switchgear system of FIG. **1**.

[0030] FIG. **4** is a cross-sectional view of the loadbreak module of FIG. **3**, taken along line **44** in FIG. **3**.

[0031] FIG. **5** is a cross-sectional view of the loadbreak module of FIG. **3**, taken along line **55** in FIG. **3**.

[0032] FIG. **6** is a perspective view of a first terminal of the loadbreak module of FIG. **3**.

[0033] FIG. **7** is a bottom view of the first terminal of FIG. **6**.

[0034] FIG. **8** is a perspective view of a vacuum interrupter assembly of the loadbreak module of FIG. **3**.

[0035] FIG. **9** is a perspective view of a base assembly of the loadbreak module of FIG. **3**, including a second terminal.

[0036] FIG. **10** is a side view of the loadbreak module of FIG. **3**.

[0037] FIG. **11** is perspective view illustrating another embodiment of the switchgear system of FIG. **1**.

[0038] FIG. **12** is a perspective view of the switchgear system of FIG. **11**, with portions hidden.

[0039] FIG. **13** is a partially exploded perspective view illustrating a disconnect switch assembly of the switchgear system of FIG. **11**.

[0040] FIG. **14** is an exploded perspective view of the disconnect switch assembly of FIG. **13**.

[0041] FIG. **15** is a schematic view of a terminal assembly according to another embodiment and which may be used with the switchgear systems of FIGS. **1** and **11**.

[0042] Before any embodiments of the disclosure are explained in detail, it is to be understood that the disclosure is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The disclosure is capable of other embodiments and of being practiced or of being carried out in various ways.

[0043] Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. For example, the use of directional terms such as upper, lower, top, bottom, left, and right are used for descriptive purposes only with reference to the particular orientations illustrated in the figures.

DETAILED DESCRIPTION

[0044] FIGS. **1-15** illustrate embodiments of a switchgear system **10**. The illustrated switchgear system **10** is a three-phase switchgear system **10** that is configured for use in a three-phase power distribution system. The switchgear system **10** may be a medium-voltage switchgear system for electrical power distribution/segmentation at maximum voltages up to, for example, 15.5 kilovolts ("kV"), 15 kV, 27 kV, 38 kV, etc. and continuous currents of up to, for example, 200 Amps ("A"), 300 A, 400 A, 500 A, 600 A, 800 A, 900 A, etc. in certain embodiments. As described in greater detail below, the switchgear system **10** includes components with high performance solid-dielectric insulation, allowing the components to be contained within a compact enclosure but without the need for the enclosure to be filled with sulfur hexafluoride (SF6) insulating gas, which is a potent greenhouse gas increasingly subject to government regulations.

[0045] With reference to FIGS. **1**, **11**, and **12**, the illustrated switchgear system **10** includes a plurality of loadbreak modules **14**, **18**, **22** supported on a shelf **27** within an enclosure **26** (only a portion of which is illustrated in FIGS. **1** and **12**). In some embodiments, the enclosure **26** contains atmospheric air, and in such embodiments, the enclosure **26** may not be hermetically sealed. In other embodiments, the enclosure may contain a non-SF6 insulating gas, including but not limited to a natural origin gas such as carbon dioxide. In yet other embodiments, the enclosure **26** may be omitted.

[0046] The loadbreak modules **14**, **18**, **22** each correspond with a respective phase of the three-phase power distribution system and are otherwise identical. As such, details of the loadbreak modules **14**, **18**, **22** are described herein with reference to the loadbreak module **14**. In some embodiments (e.g., FIG. **12**), the switchgear system **10** may include multiple "ways" or rows, each containing three loadbreak modules **14**, **18**, **22**. For example, the switchgear system **10** illustrated in FIG. **12** includes four rows of three loadbreak modules **14**, **18**, **22**, such that the switchgear system **10** is a four-way switchgear system with twelve total loadbreak modules **14**, **18**, **22**. In other embodiments, the switchgear system **10** may be configured as a single-way system (as shown in FIG. **1**), a two-way system, a three-way system, a five-way system, or a system with any other desired number of ways. In yet other embodiments, the switchgear system **10** may be configured as a single-phase switchgear system with one or more ways each containing only a single loadbreak module (e.g., loadbreak module **14**).

[0047] Referring now to FIG. **2**, the illustrated loadbreak module **14** includes a first terminal **30**, a vacuum interrupter assembly **34**, and a base assembly **38** including a second terminal **40**. The first terminal **30** and the second terminal **40** are configured to be mechanically and electrically connected to a first conductor **50** (e.g., a supply-side conductor) and a second conductor **42** (e.g., a load-side conductor), respectively. The illustrated first conductor **50** and second conductor **42** are each covered with an insulator (e.g., a silicone or rubber sleeve or coating, a molded epoxy, or the like). As described in greater detail below, the first terminal **30**, the vacuum interrupter assembly **34** and the base assembly **38** are coupled (e.g., clamped) together to form the loadbreak module **14**, which is operable to selectively break and establish an electrical connection between the first terminal **30** and the second terminal **40** (and thus, between the first conductor **50** and the second conductor **42**).

[0048] With continued reference to FIG. **2**, in the illustrated embodiment, the first terminal **30** includes a conductive lug **54** that connects the vacuum interrupter assembly **34** to the first conductor **50**. The first terminal **30** is surrounded by a first terminal housing **58** such that the first terminal **30** and first terminal housing **58** form a first terminal assembly **31**. The first terminal housing **58** is an electrical insulator (e.g., a solid dielectric material such as epoxy) and may, in some embodiments, be molded as a single, unitary body.

[0049] With reference to FIG. **5**, a conductive shield **174** is molded within the first terminal housing **58** and affixed to the conductive lug **54** by fasteners **178**. Referring to FIG. **6**, the first terminal housing **58** includes a first upstanding portion **190** and an opposite second upstanding portion **194**. A U-shaped recess **182** is defined between the upstanding portions **190**, **194**. The conductive lug **54** is positioned within the recess **182**, and the recess **182** is sized and shaped to receive an end portion **50*a*** of the first conductor **50** (FIG. **2**), such that the connection between the conductive lug **54** and the first conductor **50** is disposed entirely within the recess **182**. The shape of the first terminal housing **58** and the embedded shield **174** provides electrical stress reduction in the region of the conductive lug **54**.

[0050] Returning to FIG. **2**, the illustrated vacuum interrupter assembly **34** includes a vacuum bottle **62** that encloses a fixed contact **66** and a movable contact **70**. The fixed contact **66** is electrically connected to the conductive lug **54**. The movable contact **70** is movable along a first axis **A1** between a closed position, shown in FIG. **2**, in which the movable contact **70** engages the fixed contact **66**, and an open position (not shown), in which the movable contact **70** is spaced apart from the fixed contact **66**. The vacuum interrupter assembly **34** further includes an overmolded electrical insulator, such as a sleeve **74**, that surrounds the vacuum bottle **62**. In the illustrated embodiment, the sleeve **74** is made of a resilient and flexible dielectric material, such as silicone or rubber. In some embodiments, the sleeve **74** may be formed separately and then applied to the outer surface of the vacuum bottle **62**. The base assembly **38** includes an interchange **78** made of an electrical conductor. The interchange **78** is electrically connected to the movable contact **70** and allows the movable contact **70** to move longitudinally along the first axis A**1** within the interchange **78**.

[0051] With reference to FIGS. **2** and **9**, the base assembly **38** further includes a body or base housing **82** and a second terminal housing **87**, which, in the illustrated embodiment, is an integral portion of the base housing **82**. The illustrated base housing **82** is an electrical insulator (e.g., a solid dielectric material such as epoxy) and may, in some embodiments, be molded as a single unitary body. A cavity **85** in the base housing **82** below the interchange **78** receives an operating rod **106**, which couples the movable contact **70** to a loadbreak actuator (e.g., an electromagnetic actuator, a manual actuating handle, or any other suitable actuator; not shown) located below the shelf **27**. The loadbreak actuator is operable to move the movable contact **70** along the first axis A**1** between its open and closed positions to selectively break and establish an electrical connection between the first terminal **30** and the second terminal **40**. The loadbreak actuator may be, for example, the loadbreak actuator mechanism described and illustrated in U.S. patent application Ser. No. 17/543,363, filed Dec. 6, 2021, in the name of G & W Electric Company ("the G & W Application"), the entire content of which is incorporated herein by reference. In some embodiments, the loadbreak actuator is configured such that the three loadbreak modules **14**, **18**, **22** for each way of the switchgear system **10** are actuated together.

[0052] With reference to FIG. **2**, the first terminal assembly **31** in the illustrated embodiment is configured such that the first conductor **50** extends along a second axis A**2** perpendicular to the first axis A**1**. The second terminal housing **87**, which is annularly shaped, extends along a third axis A3 perpendicular to the first axis A**1** and parallel to the second axis A**2**. In other embodiments, the axes A1, A2, A3 may be oriented differently. For example, the first terminal assembly **31** may be arranged such that the axis A**2** of the first conductor **50** extends perpendicular to the axis A3 of the second conductor **42**.

[0053] In the illustrated embodiment, the second terminal **40** includes a female connector **86** (e.g., a tulip connector) received within the second terminal housing **87** and connected to (e.g., threaded into) the interchange **78**. The female connector **86** is configured to receive a male portion **42***a* of the second conductor **42** to electrically connect the second conductor **42** with the interchange **78** and thus, with the movable contact **70**. In other embodiments, other types of connectors may be used to electrically connect the second conductor **42** with the interchange **78**. For example, the second conductor **42** may include the female connector **86**, and the second terminal **40** may include the male portion **42***a*.

[0054] With continued reference to FIG. **2**, the insulation surrounding the second conductor **42** includes a flange **89** in the illustrated embodiment, which is coupled to an outer face of the second terminal housing **87** (e.g., by a plurality of fasteners, which may be insulated fasteners in some embodiments). The flange **89** and the outer terminal housing **87** thus cooperate to fully enclose and insulate the interface of the connectors **42***a*, **86**. In some embodiments, a compressible resilient seal (e.g., a silicone seal) may be provided between the flange **89** and the second terminal housing **87** to further insulate the interface. In some embodiments, the second conductor **42** and the second terminal housing **87** may include other cooperating geometries to enclose and insulate the interface of the connectors **42***a*, **86**.

[0055] In the illustrated embodiment, the second conductor **42** is connected to a bushing assembly **46** that is affixed to the enclosure **26** to provide electrical access to a voltage of the second conductor **42** from an exterior of the enclosure **26** (and through, for example, a front panel **28** of the enclosure **26**). The second conductor **42** electrically connects the second terminal **40** to an inner terminal **90** of the bushing assembly **46**. For example, in the illustrated embodiment, the second conductor **42** includes a female connector **42***b* (e.g., a tulip connector) opposite the male portion **42***a*. The bushing assembly **46** includes an internal conductor **98** (i.e., a third conductor) with a male portion **98***a* received by the female connector **42***b* of the second conductor **42**. In other embodiments, other types of connectors may be used to electrically connect the second conductor **42** to the internal conductor **98** of the bushing assembly **46**.

[0056] With continued reference to FIG. **2**, the insulation surrounding the second conductor **42** includes a cup-shaped end **91** in the illustrated embodiment, which surrounds a cup-shaped end **93** of an insulating body **102** of the bushing assembly **46**. The flange two cup-shaped ends **91**, **93** face each other and cooperate to fully enclose and insulate the interface of the connectors **42***b*, **98***a*. In some embodiments, one or more a compressible resilient seals (e.g., a silicone o-ring seal) may be provided between the outer surface of the cup-shaped end **93** and the inner surface of the cup-shaped end **91** to further insulate the interface between the two connectors **42***b*, **98***a*. In some embodiments, the insulating body **102** and the second conductor **42** may include other cooperating geometries to enclose and insulate the interface of the connectors **42***b*, **98***a*.

[0057] The internal conductor **98** of the bushing assembly **46** electrically connects the inner terminal **90** to an outer terminal **94** of the bushing assembly **46**. The third conductor **98** extends through the front panel **28** of the enclosure **26**, and the insulating body **102** of the bushing assembly **46** electrically insulates the conductive components of the bushing assembly **46** from the enclosure **26**, such that the enclosure **26** is a "dead front" enclosure **26**. The bushing assembly **46** is mounted to the enclosure **26** such that the outer terminal **94** is accessible from an exterior of the enclosure **26** to connect, for example, an electrical cable.

[0058] With reference to FIGS. **3** and **10**, a clamping assembly **110** fixes together the first terminal assembly **31**, the vacuum interrupter assembly **34**, and the base assembly **38**. The clamping assembly **110** may include a variety of clamping mechanisms to clamp the first terminal assembly **31**, the vacuum interrupter assembly **34**, and the base assembly **38**. In the illustrated embodiment, the clamping assembly **110** includes a plurality of (and more specifically, four) clamping members **114***a*, **114***b*, **114***c*, **114***d*, shown in the illustrated embodiment as threaded clamping rods or studs. The clamping rods **114***a-d* are made of an insulating material such as fiberglass. With reference to FIG. **10**, each clamping member **114***a*, **114***b*, **114***c*, **114***d* extends along and defines a respective clamping axis (e.g., the clamping member **114***b* defines the clamping axis A**5**, and the clamping member **114***d* defines the clamping axis A**6**). In the illustrated embodiment, the first axis A**1** is parallel to the clamping axes A**5**, A**6**.

[0059] Referring again to FIGS. **3** and **10**, a first end of each clamping rod **114***a-d* connects to a nut **118***a*, **118***b*, **118***c*, **118***d* provided adjacent the first terminal assembly **31**, and a second end or head of each clamping rod **114***a-d* is received by and engages a receptacle **122***a*, **122***b*, **122***c*, **122***d* provided in the base housing **82**. With reference to FIGS. **3-7** and **10**, the clamping rods **114***a-d* extend through holes **198***a*, **198***b*, **198***c*, **198***d* in a plate **126** provided around the first terminal housing **58** such that the nuts **118***a-d* are engageable with the plate **126** to transmit an axial clamping force from the clamping rods **114***a-d* to the first terminal housing **58**. The plate **126** is made of an insulating material such as fiberglass, and may be made of the same material as the clamping rods **114***a-d*. Clamping the first terminal housing **58** against the sleeve **74** and clamping the base housing **82** against the sleeve **74** provides respective dielectric seals between the respective components, as described in greater detail below, as the sleeve **74** is compressed between the first terminal housing **58** and the base housing **82**.

[0060] With reference to FIG. **8**, the illustrated sleeve **74** includes a plurality of external circumferential sheds **130** surrounding the sleeve **74**, such that the sleeve **74** has an undulating outer profile. The sleeve **74** includes an outer sealing ridge **134** and an inner sealing ridge **138** located on an upper end of the sleeve **74** adjacent the first terminal assembly **31**. In other embodiments, the sleeve **74** may include more or fewer sealing ridges **134**, **138**. Illustrated in FIGS. **5** and **7**, the first terminal housing **58** includes an outer sealing recess **142** and an inner sealing recess **146** configured to respectively receive the outer sealing ridge **134** and the inner sealing ridge **138**. With reference to FIGS. **4** and **5**, the first terminal housing **58** includes an outer circumferential lip **150** that receives and surrounds the upper end of the sleeve **74**. The sealing ridges **134**, **138**, the sealing recesses **142**, **146**, and the lip **150** define a plurality of inter-engaging features that cooperate to form a dielectric seal between the first terminal assembly **31** and the vacuum interrupter assembly **34** upon application of a clamping force by the clamping assembly **110**.

[0061] With reference to FIG. **4**, the sleeve **74** includes a bottom portion **154** extending under a bottom end of the vacuum bottle **62** opposite the first terminal assembly **31** and adjacent the base assembly **38**. The bottom portion **154** transitions into a cylindrical sleeve portion **170** that abuts an inner surface of a receiving portion **166** of the base housing **82** to form a dielectric seal between the base housing **82** and the sleeve **74** upon clamping by the clamping assembly **110**.

[0062] In some embodiments, a method of manufacturing the switchgear system **10** includes providing a vacuum bottle **62** enclosing the fixed contact **66** and the movable contact **70**. The movable contact **70** is movable along the first axis A**1**. The method further includes surrounding the vacuum bottle **62** with the sleeve **74** to form the vacuum interrupter assembly **34**. The method further includes providing the first terminal assembly **31** including the conductive lug **54** surrounded by the first terminal housing **58**. The conductive lug **54** is electrically connected to the fixed contact **66**. The method further includes providing the base assembly **38** including an interchange **78** and the second terminal **40**, both electrically connected to the movable contact **70**. The interchange **78** and the second terminal **40** are both surrounded by the base housing **82**. The method further includes providing the vacuum interrupter assembly **34** such that the vacuum interrupter assembly **34** is operable to selectively break or establish an electrical pathway between the conductive lug **54** and the second terminal **40** in response to movement of the movable contact **70** relative to the fixed contact **66**. The method further includes forming the vacuum interrupter assembly **34**, the first terminal assembly **31**, and the base assembly **38** as separate pieces. The method further includes clamping the vacuum interrupter assembly **34** between the first terminal housing **58** and the base housing **82** to form the loadbreak module **14**. The method further includes providing the loadbreak module **14** within the enclosure **26**, the enclosure containing atmospheric air.

[0063] Because the first terminal assembly **31**, the vacuum interrupter assembly **34**, and the base assembly **38** are each formed as separate, insulated components, which are subsequently coupled together by the clamping assembly **110**, the first terminal assembly **31**, the vacuum interrupter assembly **34**, and the base assembly **38** may be independently removable and replaceable in the case of, for example, a repair for wear or general maintenance. Alternatively, or additionally, the first terminal assembly **31**, the vacuum interrupter assembly **34**, or the base assembly **38** may be replaced with another assembly.

[0064] For example, with reference to FIG. **12**, the first terminal assembly **31** may be replaced with a disconnect switch assembly **214**, (which may be also referred to as a third terminal assembly **214**). When the first terminal assembly **31** is replaced with the disconnect switch assembly **214**, the disconnect switch assembly **214** is operable to selectively open a connection between the fixed contacts **66** and the first conductor **50**. Thus, the switchgear system **10** may be provided with or without a disconnect switch assembly **214** while being able to use the same vacuum interrupter assembly **34** and base assembly **38**.

[0065] In the illustrated embodiment, the disconnect switch assembly **214** is a three-phase disconnect switch assembly with three terminals **218** (which may be referred to as line terminals) supported by a disconnect switch housing **222**. The disconnect switch housing **222** is coupled to each of the three loadbreak modules **14**, **18**, **22** in a respective way of the switchgear system **10**. The first conductors **50** in the illustrated embodiment are configured as bus bars that extend between and interconnect the line terminals **218** across the ways. Thus, because the switchgear system **10** illustrated in FIG. **12** is a four-way system, the switchgear system **10** includes four disconnect switch assemblies **214**, all contained within the enclosure **26**. With reference to FIG. **11**, the enclosure **26** may include a plurality of windows **225** in the front panel **28**, generally aligned with the disconnect switch assemblies **214**. The windows **225** may allow an operator to visually confirm whether the disconnect switch assemblies **214** are in an open (non-conducting) position or a closed (conducting position).

[0066] Referring now to FIG. **13**, the disconnect switch housing **222** is made of an electrically insulating material (e.g., epoxy resin, polycarbonate, or any other suitable material) and includes first and second housing halves **230**, **232** coupled together (e.g., by fasteners **235**). The housing halves **230**, **232** capture and rotatably support the ends of a rotor **236**, described in greater detail below.

[0067] In the illustrated embodiment, the second housing half **232** includes three plates **226** (one corresponding with each loadbreak module **14**, **18**, **22**). Similar to the plate **126** described above with reference to FIG. **7**, each plate **226** includes an outer sealing recess **242** and an inner sealing recess **246** configured to respectively receive the outer sealing ridge **134** and the inner sealing ridge **138** of the sleeve **74** on the vacuum interrupter assembly **34** of each module **14**, **18**, **22**.

[0068] The disconnect switch housing **222** can be clamped to the vacuum interrupter assemblies **34** via the clamping assemblies **110** in generally the same manner as the first terminal housing **58** described above, and the inter-engaging features of the ridges **134**, **138** and sealing recesses **242**, **246** cooperate to form a dielectric seal between the plates **226** of the disconnect switch housing **222** and the vacuum interrupter assembly **34** upon application of a clamping force by the clamping assemblies **110**.

[0069] With reference to FIG. **14**, each of the housing halves **230**, **232** includes a plurality of dividing walls **250**, each having a semi-circular recess **254** formed at a center of the dividing wall **250**. When the housing halves **230**, **232** are assembled, the recesses **254** of the two halves **230**, **232** cooperate to form circular bores through which the rotor **234** extends. In the illustrated embodiment, the rotor **234** includes pairs of sheds **257** extending outwardly from a shaft body **256** of the rotor **234**. The sheds **257** have a diameter larger than the diameter of each circular bore defined by the recesses **254**. When the housing halves **230**, **232** are assembled, the dividing walls **250** are sandwiched between the two sheds **257** in each pair. The sheds **257** and dividing walls **250** thus separate the disconnect switch housing **222** into a plurality of (e.g., three) disconnect switch chambers **258** and provide an increased creepage distance between adjacent chambers **258**.

[0070] With continued reference to FIG. **14**, the rotor **234** includes three contact supports **262** extending radially outwardly from the shaft body **256**. The contact supports **262** are centered between two pairs of sheds **257**. A contact bar **266** through each of the contact supports **262** such that opposite ends of the contact bar **266** are exposed.

[0071] The contact bar **266** is engageable with the line terminal **218** at one end and with an input terminal **270** at the opposite end when the rotor **234** is in a first or closed position. The contact bar **266** and terminals **218**, **270** for each phase are located within a respective disconnect switch chamber **258**. The input terminal **270** is electrically connected to the fixed contact **66** of the associated loadbreak module **14**, **18**, **22**. Thus, when the rotor **234** is in the closed position, the disconnect switch assembly **214** electrically connects the first conductors **50** with the fixed contacts **66**.

[0072] The rotor **234** (including the shaft body **256**, sheds **257**, contact supports **262**, and contact bar **266**) is rotatable to a second or open position, in which the contact bar **266** disengages from the line terminal **218** and the input terminal **270**. In the open position, the disconnect switch assembly **214** thus electrically disconnects the fixed contacts **66** from the first conductors **50**. In some embodiments, the disconnect switch housing **222** may encase conductive shields, such as the conductive shield **174**, positioned around either or both of the line terminal **218** and the input terminal **270** for electrical stress reduction at the respective terminals **218**, **270**. The rotor **234** may be actuated between the open position and the closed position by a disconnect actuator (not shown), such as the disconnect actuator mechanism described and illustrated in the G & W Application.

[0073] Now referring to FIG. **15**, in some embodiments, the base assembly **38** may be replaced with a fourth terminal assembly **214'**, illustrated schematically in FIG. **15**. In the illustrated embodiment, the fourth terminal assembly **214'** includes a base housing **82'** having two second terminal housings **87'** extending from the base housing **82'** in opposite directions. The second terminal housings **87'** may each enclose a terminal electrically connected to an interchange. The fourth terminal assembly **214'** may therefore be used to provide the switchgear system **10** with additional terminals, while being able to use the same first terminal assembly **31** and vacuum interrupter assembly **34**.

[0074] Although the disclosure has been described in detail with reference to certain preferred embodiments, variations and modifications exist within the scope and spirit of one or more independent aspects of the disclosure as described.

[0075] Various features of the disclosure are set forth in the following claims.

What is claimed is:

1. A switchgear system comprising:

an enclosure containing atmospheric air; and

a loadbreak module disposed within the enclosure, the loadbreak module including:

a vacuum interrupter having:

a vacuum bottle enclosing a fixed contact and a movable contact, the movable contact movable along a first axis, and

a sleeve surrounding the vacuum bottle,

an interchange surrounded by a base housing, the interchange electrically connected to the movable contact,

a first terminal surrounded by a first terminal housing, the first terminal electrically connected to the fixed contact,

a second terminal electrically connected to the movable contact through the interchange, and

a clamping assembly extending between the base housing and the first terminal housing,

wherein the vacuum interrupter is operable to selectively break or establish an electrical pathway between the first terminal and the second terminal in response to movement of the movable contact relative to the fixed contact,

wherein the vacuum interrupter is clamped between the first terminal housing and the base housing by the clamping assembly.

2. The switchgear system of claim **1**, further comprising a first conductor coupled to the first terminal and a second conductor coupled to the second terminal, and wherein the first conductor and the second conductor are each surrounded by insulation.

3. The switchgear system of claim **1**, wherein the sleeve includes an outer sealing ridge and an inner sealing ridge, both sealing ridges positioned on an end of the sleeve adjacent the first terminal.

4. The switchgear system of claim **1**, wherein the sleeve is made of a resilient insulating material overmolded on the vacuum bottle.

5. The switchgear system of claim **4**, wherein the sleeve is compressed between the first terminal housing and the base housing.

6. The switchgear system of claim **4**, wherein the sleeve includes a plurality of external circumferential ribs.

7. The switchgear system of claim **1**, wherein the first terminal housing is made of a molded solid dielectric material.

8. The switchgear system of claim **1**, wherein the base housing is made of a molded solid dielectric material.

9. The switchgear system of claim **1**, wherein the clamping assembly includes a plurality of clamping members extending between the first terminal housing and the base housing, the clamping members applying a force to the first terminal housing and to the base housing to compress the sleeve between the first terminal housing and the base housing to form a first dielectric seal between the first terminal housing and the sleeve and to form a second dielectric seal between the base housing and the sleeve.

10. The switchgear system of claim **9**, wherein each clamping member includes a threaded stud made of fiberglass.

11. A three-phase switchgear system comprising the switchgear system of claim **1**, wherein the loadbreak module is a first loadbreak module, and wherein the three-phase switchgear system further comprises:

a second loadbreak module identical to the first loadbreak module corresponding to a second phase of the three-phase switchgear system; and

a third loadbreak module identical to the first loadbreak module corresponding to a third phase of the three-phase switchgear system,

wherein the first, second, and third loadbreak modules are disposed within the enclosure.

12. The switchgear system of claim **1**, wherein a first terminal assembly includes the first terminal and the first terminal housing, and wherein the first terminal assembly is interchangeable with a disconnect switch assembly.

13. A switchgear system for a power distribution system, the switchgear system comprising:

a vacuum interrupter including an insulating sleeve and a vacuum bottle surrounded by the sleeve, the vacuum bottle enclosing a fixed contact and a movable contact;

a first terminal assembly including a first terminal configured to be electrically connected to the fixed contact and a first terminal housing made of a molded solid dielectric material, the first terminal surrounded by the first terminal housing; and

a base assembly including a base housing made of a molded solid dielectric material, an interchange supported within the base housing and configured to be electrically connected to the movable contact, and a second terminal electrically connected to the interchange;

wherein the vacuum interrupter is operable to selectively break or establish an electrical pathway between the first terminal and the second terminal in response to movement of the movable contact relative to the fixed contact; and

a disconnect switch assembly configured to be modularly interchangeable with the first terminal assembly.

14. The switchgear system of claim **13**, wherein the first terminal assembly, the vacuum interrupter, and the second terminal assembly are clamped together to provide a first dielectric seal between the first terminal housing and the sleeve and to provide a second dielectric seal between the second terminal housing and the sleeve.

15. The switchgear system of claim **13**, wherein the disconnect switch assembly, the vacuum interrupter, and the second terminal assembly are clamped together to provide a first dielectric seal between the disconnect switch assembly and the sleeve and to provide a second dielectric seal between the second terminal housing and the sleeve.

16. The switchgear system of claim **13**, wherein the disconnect switch assembly includes a housing, a rotor supported by the housing and including a contact bar, a line terminal, and an input terminal opposite the line terminal, wherein the input terminal is configured to be electrically connected to the fixed contact, and wherein the rotor is rotatable between a closed position, in which the contact bar electrically connects the line terminal and the input terminal, and an open position, in which the line terminal and the input terminal are electrically disconnected.

17. The switchgear system of claim **16**, wherein the housing of the disconnect switch assembly includes a plurality of dividing walls each sandwiched between a pair of sheds extending from a shaft portion of the rotor.

18. A method of manufacturing a switchgear system, the method comprising:

providing a vacuum bottle enclosing a fixed contact and a movable contact, the movable contact movable along a first axis;

surrounding the vacuum bottle with a sleeve to form a vacuum interrupter assembly;

providing a first terminal assembly including a first terminal surrounded by a first terminal housing, the first terminal electrically connected to the fixed contact;

providing a base assembly including an interchange and a second terminal both electrically connected to the movable contact, the interchange and the second terminal both surrounded by a base housing; and

clamping the vacuum interrupter assembly between the first terminal housing and the base housing to form a loadbreak module.

19. The method of claim **18**, wherein surrounding the vacuum bottle with the sleeve includes overmolding the sleeve on the vacuum bottle.

20. The method of claim **18**, wherein the sleeve is made of a resilient insulating material.

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