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(71) Applicant: **GENERAL ELECTRIC COMPANY** [US/US]; 1 River Road, Schenectady, NY 12345 (US).

(72) Inventors: **FREITAS, Mari, Keiko**; 41 Woodford Avenue, Plainville, CT 06062 (US). **HAQUE, Enamul**; 41 Woodford Avenue, Plainville, CT 06062 (US). **MEYER-HAACK, Wolfgang**; 41 Woodford Avenue, Plainville, CT 06062 (US). **TIWARI, Dhirendra**; 41 Woodford Avenue, Plainville, CT 06082 (US).

(74) Agents: **MIDGLEY, Stephen G.** et al.; General Electric Company, Global Patent Operation, 3135 Easton Turnpike, Fairfield, CT 06828 (US).

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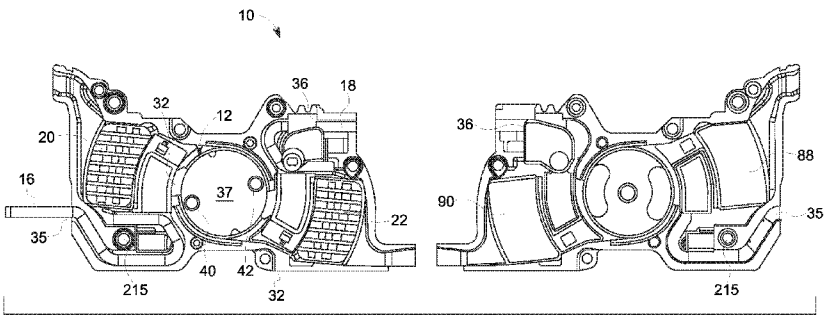


FIG. 1

(57) Abstract: A circuit breaker housing assembly is disclosed. The housing (47) includes a first housing piece (14) defining a first interior surface (52) including a first mating surface (152), and a second housing piece (60) defining a second interior surface (62) including a second mating surface (260) which is opposingly coupled to the first mating surface to define a seam (202) therebetween. An adhesive material (201) is disposed between the corresponding first and second mating surfaces along the seam. A moveable contact is disposed in the housing and is selectively moveable with respect to a corresponding stationary contact. The first and second interior surfaces (52,62) further cooperatively define a first recess (120) therebetween, and the moveable contact assembly is disposed in said first recess.

CIRCUIT BREAKER HOUSING AND METHOD OF ASSEMBLING

BACKGROUND OF THE INVENTION

[0001] This invention relates generally to a switching device, and, more particularly, to a circuit breaker having an insulative housing.

[0002] Circuit breakers are one of a variety of switching devices, such as overcurrent protective devices, used for electrical circuit protection and isolation. A basic function of a circuit breaker may be to provide electrical system protection when an electrical abnormality (such as a short-circuit or other fault condition) occurs in any part of the circuit. In such devices, a moveable electrical contact is typically selectively engageable with a corresponding stationary contact to enable current flow. When a fault condition is detected, the circuit breaker moveable contact is automatically disengaged from the stationary contact to thereby disable current flow through the circuit. Such separating of the contacts may typically result in an arcing condition or event within the circuit breaker. To ensure the electrically live parts such as the separable contacts remain insulated, and to protect users from any arcing conditions, circuit breakers are typically constructed using a molded plastic housing or cassette enclosing the separable contacts.

[0003] In a typical rotary contact circuit breaker, electrical current enters the system from a power line. A conductive line-side strap and a conductive load-side strap typically protrude from the circuit breaker housing to facilitate connection with conductors in the electrical circuit. The current passes through the conductive line-side contact strap to a stationary contact fixed on a portion of the conductive strap within the circuit breaker housing, and then to a moveable contact. The moveable contact is fixedly attached to a conductive arm, and the arm is mounted to a rotor that is rotatably mounted in a cassette-type housing. As long as the fixed contact is engaged with, or in physical contact with, the moveable contact, the current passes from the fixed contacts to the moveable contacts to a portion of the conductive load-side contact strap disposed within the circuit breaker housing, and out of the circuit breaker via conductive cable coupled to the load-side contact strap and then to downline electrical devices or loads.

[0004] Typically, the circuit breaker housing, or cassette, is formed of two insulative mating housing portions rigidly coupled together with mechanical fasteners such as rivets. When coupled together, the two housing portions, or half-pieces, may define a seam along their corresponding mating surfaces, and further define at least one interior cavity between the mating housing portions or cassette half-pieces for housing the circuit breaker conductive parts, mechanisms, and arc chute assemblies. Additionally openings in the housing may allow the line-side and load side straps to protrude from the housing to enable connection to external circuit wiring.

[0005] In some instances, such as multi-pole circuit breakers of the type used in a three-phase electrical system, several conventional single-pole circuit breaker devices may each be housed in an individual cassette, and these cassettes, may be further cooperatively enclosed in a single conventional multi-pole circuit breaker housing.

[0006] In the event of an overcurrent condition (e.g. a short circuit), extremely high electro-magnetic forces are generated. These electro-magnetic forces repel the movable contact away from the stationary contact. In other cases, a tripping mechanism disposed within the circuit breaker housing acts to drive the movable contact away from the stationary contact. For example, when the moveable contact is fixedly attached to a rotatable arm, and the moveable contact is in contact with the stationary contact, it defines an "ON" condition for the circuit breaker. When the rotatable arm is pivoted to physically separate the stationary and moveable contacts, the circuit breaker is thereby switched to the "tripped" or "off" condition. When the circuit breaker contacts are rapidly opened or tripped, for example due to a detected short-circuit event, an electrical arc is produced between the contacts. Accordingly, there occurs a voltage corresponding to the source voltage between the stationary contact and the moveable contact, thereby carrying out the circuit breaker operation. It is common practice to employ an arc chute assembly to help extinguish this resultant arc.

[0007] Additionally, during such an arcing event, high-temperature ionized gasses are generated due to the arc, with resultant high pressure forces likewise being developed within the housing interior cavity. The ionized gas temperatures can reach or exceed 20,000°C for several milliseconds, which can vaporize the conductors and adjacent equipment. Moreover,

an arc flash can release significant energy in the form of heat, intense light, pressure waves, and/or sound waves.

[0008] Such ionized gases may conventionally be intentionally discharged through specific exhaust vent openings arranged in the circuit breaker housing. However, if the ionized gases are unintentionally discharged from even the smallest of openings, such as along a seam or other small openings in the housing around the line-side contact strap and load-side contact strap, the gases could transfer to an adjacent circuit breaker, or to nearby bus bar conductors, resulting in a phase-to-phase electrical fault. The expelled ionized gases could also cause a phase-to-ground failure with a grounded metallic panelboard enclosure within which the circuit breaker is mounted.

[0009] The circuit breaker housing must therefore be robustly coupled together to safely withstand the high pressures generated during an arcing event. Typically, a strong and relatively expensive molding material such as sheet molding compound (SMC) is used to form the housing, which requires a relatively expensive compression molding process.

[0010] It is also important that the corresponding housing pieces be mated together tightly along the seam to minimize an egress of the conductive gasses therethrough to prevent injury to nearby personnel or equipment. Since conventional circuit breaker housing portions are fastened together using strong mechanical fasteners such as rivets, undesired localized stresses in the mating housing portions may form, and thus s thickening or otherwise strengthening of the housing in the riveted areas is required. It would be advantageous to provide a strong circuit breaker housing with a robust, sealed seam formed using less expensive materials and rigidly joined together with fewer, or without, the use of mechanical fasters.

BRIEF DESCRIPTION OF THE INVENTION

[0011] In an exemplary embodiment, a circuit breaker housing or cassette assembly is disclosed. The housing includes a first housing piece defining a first interior surface including a first mating surface, and a second housing piece defining a second interior surface including a second mating surface which is opposingly coupled to the first mating surface to define a seam therebetween. An adhesive material is disposed between the corresponding

first and second mating surfaces along the seam. A moveable contact is disposed in the housing and is selectively moveable with respect to a corresponding stationary contact. The first and second interior surfaces further cooperatively define a first recess therebetween, and the moveable contact assembly is disposed in said first recess.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 depicts a front view of an embodiment of a circuit breaker housing assembly with the mating first housing piece separated from the second housing piece and rotated for clarity;

[0013] FIG. 2 depicts an embodiment of the first electrically insulative housing piece;

[0014] FIG. 3 depicts an embodiment of the second electrically insulative housing piece;

[0015] FIG. 4 depicts an exemplary rotor employed an the embodiment;

[0016] FIG. 5 is a top view of an exemplary arc chute assembly;

[0017] FIG. 6 is a view of an arc chute side member employed in the arc chute assembly of FIG. 5.

[0018] FIG. 7 is a perspective view of an embodiment of a housing assembly comprising the first and second housing halves of FIGS. 2 and 3 assembled together;

[0019] FIG. 8 is a perspective view depicting the opposite side of the housing assembly of FIG. 7;

[0020] FIG. 9 depicts the embodiment of the housing piece of FIG. 3 with an adhesive material applied to a portion of the first mating surface;

[0021] FIG. 10 depicts an end view partial cross-section of an embodiment;

[0022] FIG. 11 is a close up view of a portion of the embodiment of FIG. 10;

[0023] FIG 12 is a close up view of another portion of the embodiment of FIG. 10;

[0024] FIG. 13 depicts an embodiment of one of the housing pieces of FIG. 1 with adhesive applied to a portion of the mating surface;

[0025] FIG. 14 depicts a partial cross-section perspective view of the embodiment of FIG. 8;

[0026] FIG. 15 depicts a perspective view of an embodiment of a circuit breaker comprising three housing assemblies arranged to comprise a 3-pole circuit breaker;

[0027] FIG 16 depicts a detailed perspective view of the current path of an embodiment with all other parts removed for clarity; and

[0028] FIG. 17 depicts a perspective view of an alternative embodiment of a circuit breaker comprising three housing assemblies arranged in a 3-pole circuit breaker.

DETAILED DESCRIPTION OF THE INVENTION

[0029] Exemplary embodiments of circuit protection systems and apparatus are described herein. These embodiments enhance the quenching and controlling of gases, heat, and pressure that are generated within a circuit breaker after an arc is generated.

[0030] While various embodiments are described herein with reference to an electrical circuit breaker having one or more moveable rotary contacts, other contemplated embodiments are not so limited and may also embody other electrical devices having any number or type of moveable contacts, for example, switches or electrical switching devices such as single or multi-pole circuit switching devices, including contactors, motor starters, motor controllers, and other load controllers.

[0031] As described herein, a housing 47 (Figs. 7, 8) such as for a rotary-contact type circuit breaker, may utilize a first electrically insulative housing piece **14** and a second electrically insulative housing piece **60** arranged to mate with each other to cooperatively form the housing **47**. While the housing **47** is described herein as comprising two mating half-pieces **14, 60**, it will be appreciated that embodiments may comprise a plurality of any number of pieces joined to form the enclosure **47** without departing from the scope of the claims herein. As further described herein, a housing **47** for a movable-contact type circuit

breaker utilizes the first housing piece **14** and the second housing piece **60** arranged to adhesively mate using an adhesive element **201** (Fig. 9) disposed therebetween and thereby form an enclosure. In an embodiment, the adhesive element **201 (Fig. 9)** also seals the housing **47** along at least a portion of the seam **202** between the first and second housing pieces **14, 60** in order to strengthen the seam **202** to prevent fracture of housing **47** during an arcing event.

[0032] Referring to FIG. 1, an embodiment of a circuit breaker **10** is shown in a partially assembled state with the first electrically insulative housing piece **14** and the corresponding second electrically insulative housing half piece **60**, depicted as removed and in an unassembled condition, with some elements omitted, for clarity. A rotary contact assembly **12**, a circuit breaker conductive line-side contact strap **16**, a conductive load-side contact strap **18** and corresponding arc chutes **20**, **22** are disposed therein. The line-side contact strap **16** is configured to be electrically coupled to line-side wiring (not shown) in an electrical distribution circuit, and the load-side contact strap **18** (Fig. 7) is similarly configured to be electrically coupled to load-side wiring (not shown) via a lug (not shown) or some other known device such as a bimetallic element or current sensor (not shown). A line-side contact strap opening **35**, and a load-side contact strap opening **36**, are defined within the housing pieces **14, 60** to allow the respective line-side contact strap **16** and load-side contact strap **18** to pass therethrough. Although a single rotary contact assembly **12** is shown, it will be understood that a separate rotary contact assembly **12** may be employed within each pole of a multi-pole circuit breaker and operate in a similar manner.

[0033] Generally, in operation, an electrical current flows through the circuit breaker 10 conductive parts disposed within housing **47**. With reference to Fig. 16, where an alternative embodiment of an electrical current path 112 through a circuit breaker 10 is shown with all other parts removed for clarity, the electrical current may proceed from the line-side contact strap **16a** to a first fixed contact 123b and a corresponding first moveable contact **122a** disposed at one end of a movable contact arm **132**, then to second moveable contact **122b** disposed at a second end of the moveable contact arm **132**, then to a second fixed contact **123a**, then to the load-side contact strap **18**. The movable contact arm **32** is retained between two halves of a circular rotor 137 and arranged to move in unison with the rotor 137. For example, in response to a manual articulation of a handle **55** of the circuit breaker **10**

operating mechanism (not shown) the first and second movable contacts **122a, 122b** are selectively driven between a CLOSED and an OPEN position with respect to their corresponding fixed contacts **123a, 123b**. A first rotary contact spring **33** disposed within one side of the rotor **37**, and a second rotary contact spring **34** disposed within the opposite side of rotor **37**, extend between a pair of spring mounting pins (not shown).

[0034] The arc chute assemblies **20, 22** are positioned within the electrically insulative housing half piece **60** and adjacent the respective pairs of first fixed and first moveable contacts **123a, 122b** and second fixed and second moveable contacts **123b, 122a**. The first and second movable contacts 122b, 122a and moveable contact arm **32** move in order to selectively engage and disengage the respective first and second fixed contacts **122b, 123b.** Each arc chute assembly **20, 22** is adapted to interrupt and extinguish the arc which forms when the circuit breaker **10** is tripped, for example in response to an electrical fault, and the first and second moveable contacts **122b, 122a** are suddenly separated from the first and second fixed contacts **123a, 123b**.

[0035] Referring to FIG. 3, an embodiment of a first electrically insulative housing half piece **14** is shown. The first electrically insulative housing half piece **14** has a first interior surface **52.** A first rotor recess **186** is also formed on the interior surface **52** and operatively receives the rotor **37** therein. Arc chute recesses **88, 90** are formed on the interior surface **52** on opposite ends of the rotor recess **86** and operatively receive the respective arc chute **20, 22** therein. Load-side and line-side contact strap recesses **92, 94** are also formed on the interior surface **52** proximate the arc chute recesses **88, 90** sized and disposed to operatively receive the respective line-side and load-side contact straps **18, 16** therein. In an embodiment, load-side and line-side contact strap recesses **92, 94** extend to the corresponding load side and line-side contact strap openings **36, 35**, allowing the corresponding load-side and line–side contact straps **18, 16** to protrude from the housing **47**. A first mating surface **152** is formed on the interior surface **52** and cooperatively mates with a second mating surface **260** formed on the second housing half piece **60 (Fig. 3)** to form the housing **47**.

[0036] Referring to FIG. 2, an embodiment of the second electrically insulative housing half piece **60** is shown with circuit breaker electrical parts removed for clarity. Second electrically insulative housing half piece **60** has an interior surface **62**. A second rotor recess

286 is also formed on the interior surface 62. Arc chute recesses 88, 90 are formed on the interior surface 62 on opposite ends of the second rotor recess 286 and are sized to operatively receive the respective arc chute 20, 22 therein. Load-side and line-side contact strap recesses 92, 94 are also formed on the interior surface 62 proximate the arc chute recesses 88, 90. In an embodiment, load-side and line-side contact strap recesses 92, 94 extend to the corresponding load side and line-side contact strap openings 36, 35, allowing the corresponding load-side and line–side contact straps 18, 16 to protrude from the housing 47. The second mating surface 260 is formed on the interior surface 62 and cooperatively mates with the first mating surface 152 of the first insulative housing half 14 to form the housing 47.

[0037] In an embodiment, second electrically insulative housing half piece 60 is bonded to the first electrically insulative housing half piece 14 (FIG. 2) by a suitable adhesive 201. When the first and second housing half pieces 14, 60 are joined, at least a portion of the opposing first and second interior surfaces 52, 62 cooperatively define at least one first interior recess 120 or cavity between the first and second housing pieces 14, 60. In alternative embodiments, the at least one first recess 120 may be used to locate various circuit breaker elements such as conductors, sensing elements (not shown), and rotor 37. For example, in an embodiment, a rotor recess 186 defined in the first housing half 14, and corresponding rotor recess 286 defined in the second housing half 60, may cooperatively form the first interior recess 120 therebetween. In other embodiments, the first interior recess 120 may be cooperatively defined by a cavity, such as rotor recess 186, defined in one of the first and second housing half pieces 14, 60, and an opposing one of the corresponding first and second interior surfaces 52, 62. In another embodiment, the line-side and load-side contact strap recesses 92, 94 may cooperatively form at least one second interior recess 130.

[0038] In an embodiment, (FIGS. 7, 8) when the first and second housing half pieces 60, 14, are joined, the corresponding first and second mating surfaces 152, 260 are opposingly arranged to engagingly overlap and thereby define a seam 202 therebetween. Preferably, the adhesive 201 is disposed to uniformly distribute the stress over the entire overlapping region between the first and second housing halves 60, 14. By adhesively joining the opposing corresponding mating surfaces 152, 260, the stress distribution characteristics, inherent toughness, vibration damping resistance, and electrical and thermal insulation properties of

the adhesive **201** may be advantageously applied. Accordingly, a circuit breaker housing **42** is provided having improved dielectric performance over the prior art.

[0039] In other embodiments, one or more mechanical fasteners **203**, such as rivets or screws, may additionally be used in cooperation with the adhesive **201** material to mechanically join the first and second housing half pieces **14, 60**. The one or more fasteners **203**, may be disposed in corresponding aligned through-holes or apertures **215** provided in the respective first and second housing half pieces **14, 60** and arranged therethrough to provide a clamping force.

[0040] Referring to FIG. 4, a circular rotor **37** is shown. When operatively positioned in the second electrically insulative housing half piece **60** (FIG. **2**), the rotor **37** is rotatably supported by a shaft (not shown) and rotatably and axially mounted inside first electrically insulative housing half piece **14** (FIG. **2**). One or more rotor springs **33, 34** (FIG. 10) are positioned in rotor **37**. A pivot pin **25** extends from a central portion of the moveable contact arm **32** to a central portion of the rotor **37** to allow rotation of the moveable contact arm **32** with respect to the rotor **37**. A molded pin **114** may extend from the face **19** of rotor **37**.

[0041] In an embodiment, the rotor **37** is assembled into second electrically insulative housing half piece **60** by locating pin **114** into a centrally located aperture **158**. The pin **114** locates rotor **37** within rotor recess **68** in spaced relationship from the first and second mating surfaces **152, 260**, and permits operational travel of the rotor **37** within the recess **68**. By disposing pin **114** into aperture **158** into the second electrically insulative housing half piece **60** during assembly of the rotor **37** into second housing half piece **60,** the rotor **37** will be advantageously spaced from said seam **202**, to prevent inadvertent or undesired contact by the rotor **37** with the adhesive **201** during assembly. Additionally, as discussed in further detail herein, a blocking element **102** may additionally be disposed to prevent excess adhesive **201** from contacting the movable rotor **37**.

[0042] Referring to FIG. 5, the arc chute assembly **22** for a circuit breaker is shown. The arc chute assembly **22** includes a plurality of plates **68**, a first side member **70** and a second side member **72**. Typically, the plates **68** are metallic so as to induce magnetism thereby promoting removal of an arc generated by a short circuit interruption by the circuit breaker.

Each plate **68** has a first edge **90**, a second edge **92** opposing the first edge **90**, a third edge **94** and a fourth edge **96** opposing the third edge **94**. The first edge **90** and the second edge **92** are positioned between the third and fourth edges **94**, **96**, as shown in FIG. **5**. Each plate **68** has a protrusion **74** extending from the third edge **94** and the fourth edge **96**.

[0043] Referring to FIGS. 5 and 6, first and second side members **70**, **72** have a plurality of slots **76** formed therethrough. The protrusions **74** of the plates **68** are respectively inserted into a corresponding one of the slots **76** formed in the first and second side members **70**, **72**. The plates **68** are disposed in this manner between the first and second side members **70**, **72** and are arranged in a stacked, spaced-apart relationship to each other. Second side member **72** is identical to first side member **70**. The first and second side members **70**, **72** are assembled so as to be opposedly oriented to each other. First and second side members **70**, **72** each include a first end **98** and an opposing second end **100**. First side member **70** has a tab **80** centrally located on the second end **100** opposite to the radiused notch **78**. A tab **80** is similarly located along second side member **72**.

[0044] A second arc chute assembly **20** comprises a plurality of plates **68** and third and fourth side members **82**, **84**. Third and fourth side members **82**, **84** are identical to first and second side members **70**, **72**. Third and fourth side members **82**, **84** are assembled so as to be opposedly oriented to each other. Third side member **82** has a tab **80** centrally located on an end opposite to the radiused notch **78** of the plate **68**. A tab **80** is similarly located along the fourth side member **84**.

[0045] In an embodiment, the first arc chute assembly **22** is positioned into the first electrically insulative housing half piece **14**. Similarly, the second arc chute assembly **20** is positioned into the first electrically insulative housing half piece **14**.

[0046] Referring now to FIGS. 2-5, in an embodiment, after the first and second arc chute assemblies **22**, **20** and all other desired circuit breaker elements needed for proper functioning are assembled into the first electrically insulative housing half piece **14**, the second electrically insulative housing half piece **60** is placed over the first electrically insulative housing half piece **14** to form a complete enclosure. Alternatively, it will be understood that the first and second arc chute assemblies **22**, **20** and other desired circuit breaker elements

needed for proper functioning are assembled into the second electrically insulative housing half piece **60**, the first electrically insulative housing half piece **14** may be is placed over the second electrically insulative housing half piece **60** to form a complete enclosure.

[0047] In an embodiment, prior to joining the first and second insulative housing half pieces **14, 60**, an adhesive **201** material is applied to the second mating surface **260** of the second insulative housing half piece **60**. Alternatively, the adhesive **201** material could instead be applied to the first mating surface **152** of the first insulative housing half piece **14**. In other embodiments, the adhesive material **201** is placed on both the first and second mating surfaces **152, 260** of the first and second insulative housing half pieces **14, 60**. After the application of the adhesive **201** to the selected mating surface **152, 260**, the first and second housing half pieces **14, 60** are then carefully joined, aligning the first and second mating surfaces **152, 260** with the adhesive **201** disposed therebetween. The housing assembly may then be clamped until the adhesive material has set-up or sufficiently cured. Alternatively, the housing assembly may be additionally be clamped by fasteners **203** such as rivets, screws or clips disposed in the corresponding aligned through-holes or apertures **215, 225** provided in the respective first and second housing half pieces **14, 60**.

[0048] It is important that the adhesive **201** be carefully applied, and be prevented from flowing or otherwise migrating into the interior recesses or cavities defined in the housing interior, such as first interior recess **120,** particularly in the vicinity of the circuit breaker moving parts, such as the rotor **37** and moveable contact arm **32.** As can be seen in the cross-sectional views of Figs. 10-12 and Fig. 14, at least one of the first and second mating surfaces **152, 260** are further provided with a blocking element **102**. The blocking element **102** is configured to prevent or block the flow of any adhesive **201** into the interior recess **120** of the housing assembly. Since the seam **202** comprises an interior portion **53**, i.e., proximal to the housing **47** interior, and an exterior portion **54**, i.e., proximal to the housing **47** exterior, the blocking portion **102** is preferably disposed between said interior portion **53** of the seam **202** and the first interior recess **120**. In an embodiment, the blocking element **102** is biasedly disposed on the inboard portion of the at least one of the first and second mating surfaces **152, 260**. In another embodiment, the blocking element **102** is disposed between the adhesive material **201** and first interior recess **120**. In some embodiments, the blocking element **102** is integrally formed, for example by compression or injection molding, with at

least one of the first and second mating surfaces **152, 260**. In another embodiment, the blocking element **102** comprises a third surface **132** oriented at an angle to the first and said second mating surfaces **152, 260**. The third surface **132** is oriented to block a flow of adhesive **201** from the seam **202**. For example, in an embodiment, a moveable contact assembly **12** is operably disposed in said first interior recess **120**, and the blocking element **102** is disposed along at least one of said first and second mating surfaces **152, 260** proximal to the movable contact assembly **12**.

[0049] In various embodiments, the blocking element **102** may define one or more of a wall, rib, lip, dam, groove, and trough. While the blocking element **102** in the embodiment of Figure 10 is depicted as a wall or dam, it will be appreciated that any number of alternative blocking element **102** geometries may be employed to perform the adhesive **201** blocking function without departing from the scope of the invention. For example, one of a trough, ridge, or rib may alternatively be disposed individually or in combination to block a flow of the adhesive **201** into the first interior recess **120**.

[0050] In an embodiment, the line-side and load-side contact strap recesses **92, 94** are communicatively coupled in flow communication to the respective line-side and load-side contact strap openings **35, 36**; and the first and second mating surfaces **152, 260** are arranged proximal to at least one of the line-side and load-side contact strap recesses **92, 94**. Additionally, in an embodiment, and as depicted in of Fig. 13, the blocking element **102** is omitted in the region proximal to at least one of the line side and load side straps **16, 18**. The absence of the blocking element **102** in this region allows a flow of the adhesive **201** into the line-side and load-side contact strap recesses **92, 94** during assembly of housing **47**. When cured, the adhesive **201** is thus disposed within the line-side and load-side contact strap recesses **92, 94** and acts to seal the line-side and load-side contact strap openings **35, 36** and to thus prevent undesired venting of arcing gasses therethrough out of the housing **47** during an arcing event.

[0051] The adhesive **201** may be chosen from adhesive systems of varying compositions and chemistries and must be capable of withstanding the high temperatures and high pressures generated during arcing events. Preferably, the adhesive **201** is a structural adhesive made from thermoset polymeric resins such as epoxy and polyurethane. Such

structural adhesives may provide high shear and tensile strength and good environmental resistance.

[0052] In various embodiments, adhesive **201** may comprise either thermosetting or thermoplastic adhesives. Thermosetting adhesives include, but are not limited to one or two component epoxy and polyurethane, epoxy hybrids, acrylic, cyanoacrylates, phenolics, polyesters, polysulfide, anaerobic and room temperature vulcanizing(RTV) silicones. Thermoplastics adhesives include, but are not limited to thermoplastics resin based polyamide, polyester, polysulfone, polyolefins,, phenoxy, and elastomeric resins based butyl rubber, styrene butadiene copolymers, polychloroprene, polyisobutylene and silicone elastomers.

[0053] Adhesive **201** may alternatively comprise Hybrid systems adhesives based on silane modified polymers (SMP) that are solvent-free and isocyanate-free and based on either polyether modified silanes and polyurethane modified silanes, and are not limited to silane terminated prepolymers (STP) and silane terminated urethane (STU).

[0054] In yet other embodiments, the adhesive **201** may comprise various types of sealants which include but are not limited to hydrocarbon rubber-based, acrylic, polysulfides, polyethers, polyurethane, silicones and epoxy.

[0055] Selection of a high strength adhesive **201** enables uniform distribution of the developed stresses during an arcing event over the overlapped region of the corresponding mating surfaces **152, 26**. Additionally, the additional strength provided by the adhesive **201** enables use of less expensive molding materials to form the housing halves **14, 60**. For example, a bulk molding compound may be selected (BMC), which uses along with a less expensive molding process (injection molding) as compared to using SMC and compression molding when using mechanical rivets only to join the housing halves. Moreover, by reducing or eliminating the need for mechanical fasteners, the weight and cost of the final assembly is reduced. Another advantage of the embodiments disclosed herein, by using a structural adhesive for adhesive **201** is improved stress-distribution characteristics and inherent toughness provided by such adhesives yields bonds with superior fatigue resistance and resistance to vibration due to the viscoelastic properties of such adhesives. Yet another

advantage is that the adhesive **201** additionally functions as an electrical and thermal insulator in the joint or seam **202** between the housing halves **14, 60**.

[0056] In some embodiments, the housing halves **14, 60** are adhesively joined using an adhesive **201** without the use of mechanical fasteners **203**. In other embodiments, a combination of adhesive **201** and mechanical fasteners **203** are used. Embodiments employing the combination of adhesive **201** and fasteners **203** can provide properties that are superior to either adhesive bonding or mechanical fastening alone. For example, the number of mechanical rivets **203** needed can be reduced without sacrificing strength and reliability. Additionally, when assembling a housing employing a combination of adhesive **201** and mechanical fasteners **203**, the fasteners **203** may be employed to provide a holding or clamping force to fix the housing assembly while the adhesive **201** cures. In this way, expensive fixturing equipment and associated setup are avoided. Additionally, delays in the assembly process due to adhesive cure time are thereby eliminated or reduced to speed the overall assembly process.

[0057] In an embodiment, the corresponding first and second mating surfaces of first and second housing halves are thoroughly cleaned prior to application of the adhesive **201** and assembly. For example, a plasma treatment of the substrates for the adhesive **201**, that is the first and second mating surfaces, by not using any conventional cleaning or pretreatment process. By using plasma treatment, an improved adhesion is obtained via surface modification and increased surface energy. Preferably, a simultaneous ultrafine cleaning to remove all organic contaminants and dirt prior to bonding is performed.

[0058] While this invention has been described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but rather that the invention will include all embodiments falling within the scope of the appended claims.

[0059] The order of execution or performance of the operations in the embodiments of the invention illustrated and described herein is not essential, unless otherwise specified. That is, the operations may be performed in any order, unless otherwise specified, and embodiments of the invention may include additional or fewer operations than those disclosed herein. For example, it is contemplated that executing or performing a particular operation before, contemporaneously with, or after another operation is within the scope of aspects of the invention.

[0060] When introducing elements of aspects of the invention or embodiments thereof, the articles "a," "an," "the," and "said" are intended to mean that there are one or more of the elements. The terms "comprising," including," and "having" are intended to be inclusive and mean that there may be additional elements other than the listed elements.

[0061] This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

WHAT IS CLAIMED IS:

1. A circuit breaker comprising:

a housing, said housing comprising:

a first housing piece having a first interior surface defining a first mating surface;

a second housing piece having a second interior surface defining a second mating surface opposingly coupled to said first mating surface to define a seam therebetween;

an adhesive material disposed therebetween said corresponding first and second mating surfaces along said seam.

a moveable contact assembly selectively moveable with respect to a corresponding stationary contact, said moveable contact assembly operatively disposed therein said housing;

wherein said first and second interior surfaces further cooperatively define a first recess therebetween, and said moveable contact assembly is further disposed in said first recess.

2. The circuit breaker of claim 1 further including a blocking element disposed along at least a portion of said seam and oriented to block an ingress of said adhesive material into said first recess.

3. The circuit breaker of claim 2, wherein said seam defines an interior portion and an exterior portion, and said blocking portion is disposed between said interior portion and said first recess.

4. The circuit breaker of claim 2, wherein said blocking element is further disposed between said adhesive material and said cavity.

5. The circuit breaker of claim 2, wherein said blocking element defines a third surface oriented at an angle to said first and said second surfaces.

6. The circuit breaker of claim 2, wherein said blocking element is integrally formed with at least one of said first and second mating surfaces.

7. The circuit breaker of claim 2, wherein said blocking feature is at least one of a wall, rib, lip, dam, groove, and trough.

8. The circuit breaker of claim 2, wherein said blocking feature is further disposed proximal to said movable contact assembly.

9. The circuit breaker of claim 2, wherein said housing further defines an opening therethrough;

said first and second interior surfaces further cooperatively define a second recess therebetween, said second recess extending to said opening;

a conductor disposed in said second recess; and

said adhesive material is disposed within a portion of said third recess between said conductor and said at least one of said first and second interior surface.

10. The circuit breaker of claim 9, wherein said blocking element disposed along at least a portion of said seam is omitted from portion of said seam proximal to said second recess.

11. The circuit breaker of claim 2, wherein a portion of said cavity is defined by a respective conductive strap recess opposingly disposed in each of said first and second interior surfaces;

a conductive strap disposed in said cavity; and

said adhesive material is disposed within said interior cavity between the first and second interior surfaces and said conductive strap to prevent an egress of gasses from the cavity during an arcing event.

12. The circuit breaker of claim 1 wherein the adhesive is selected from a group consisting of thermosetting adhesives, thermoplastic adhesives, hybrid adhesive systems, and sealants.

13. The circuit breaker of claim 1 wherein said first and second cassette half pieces are further coupled by at least one mechanical fastener.

14. The circuit breaker of claim 13 wherein the fastener comprises one of a rivet, screw, or clip.

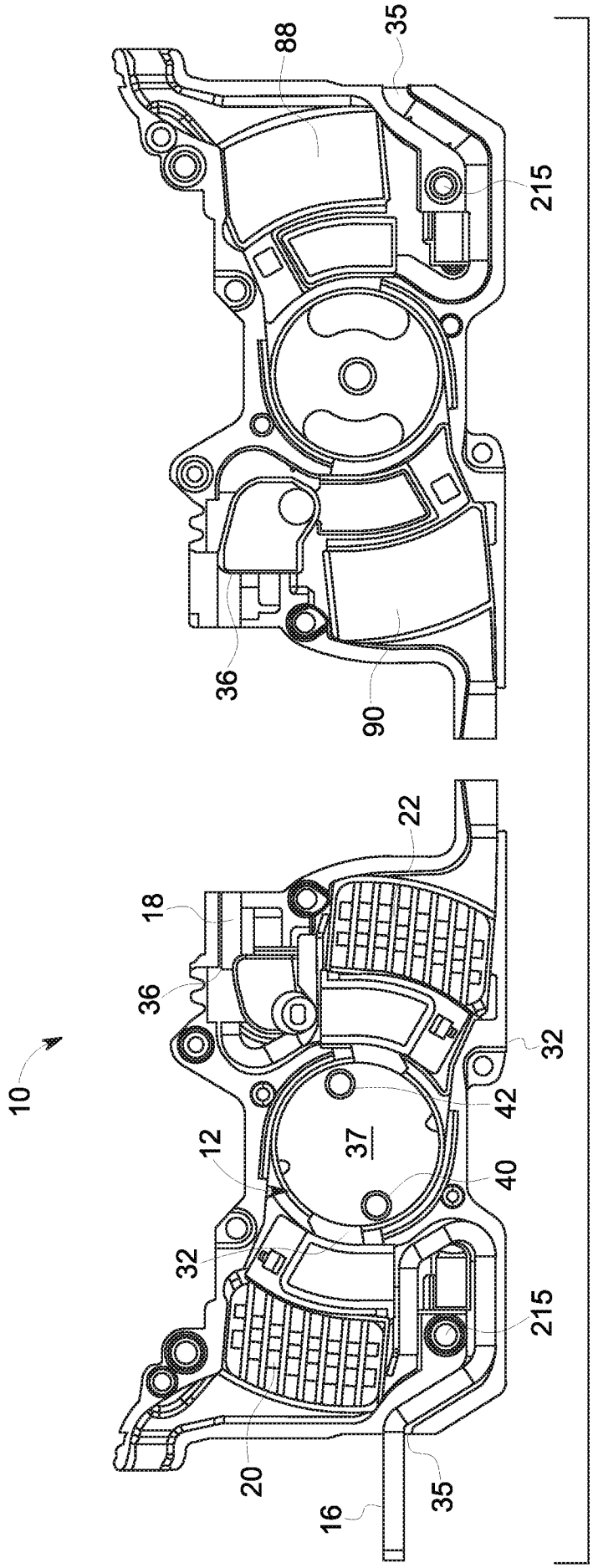


FIG. 1

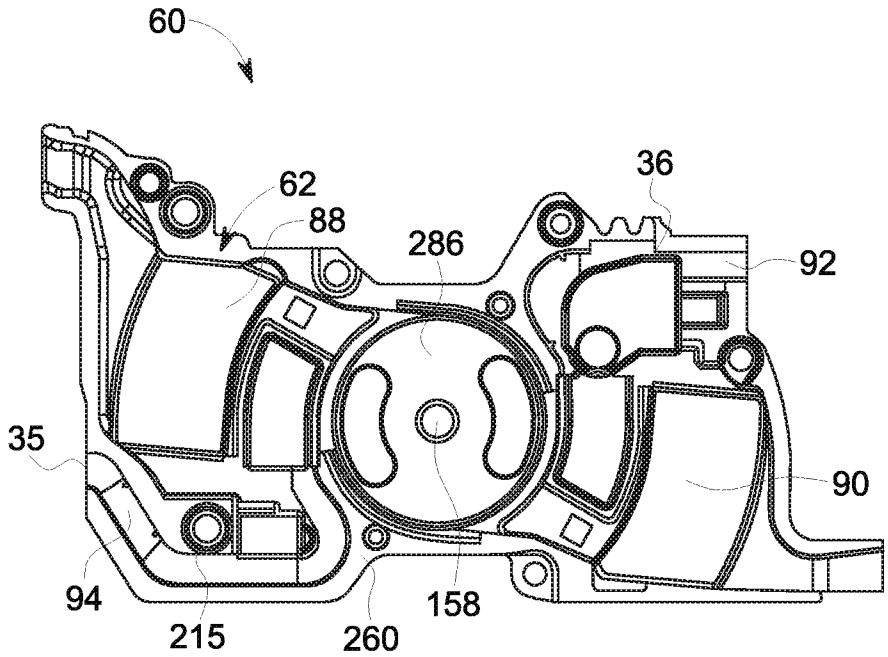


FIG. 2

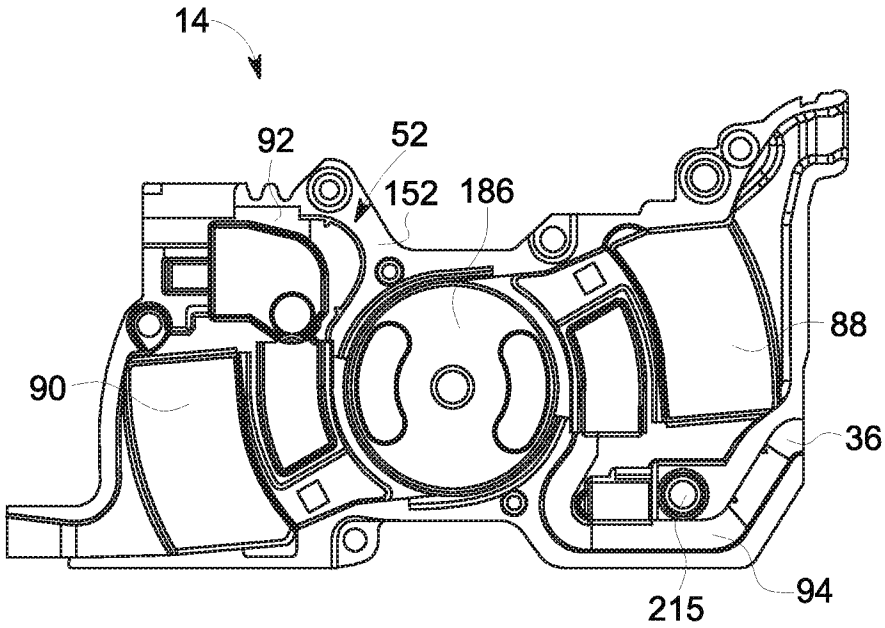


FIG. 3

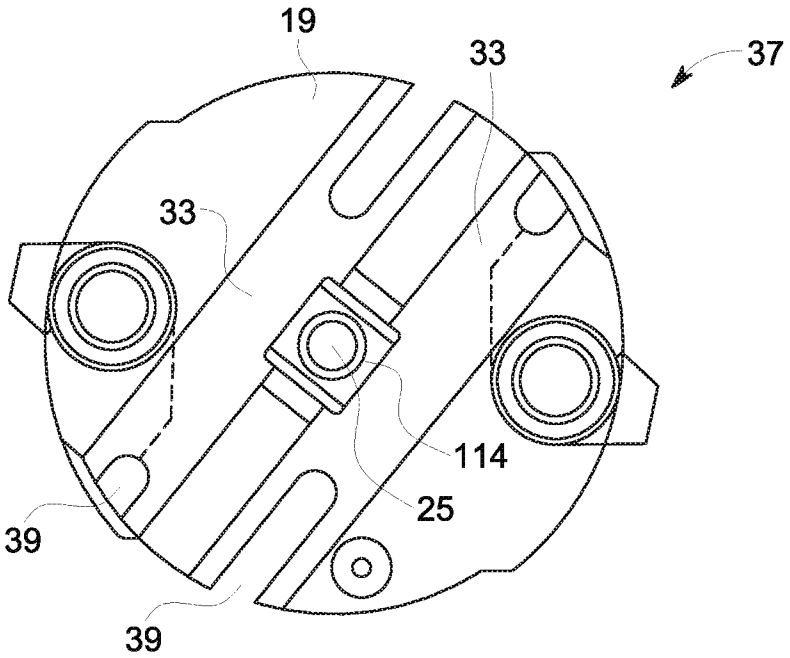


FIG. 4

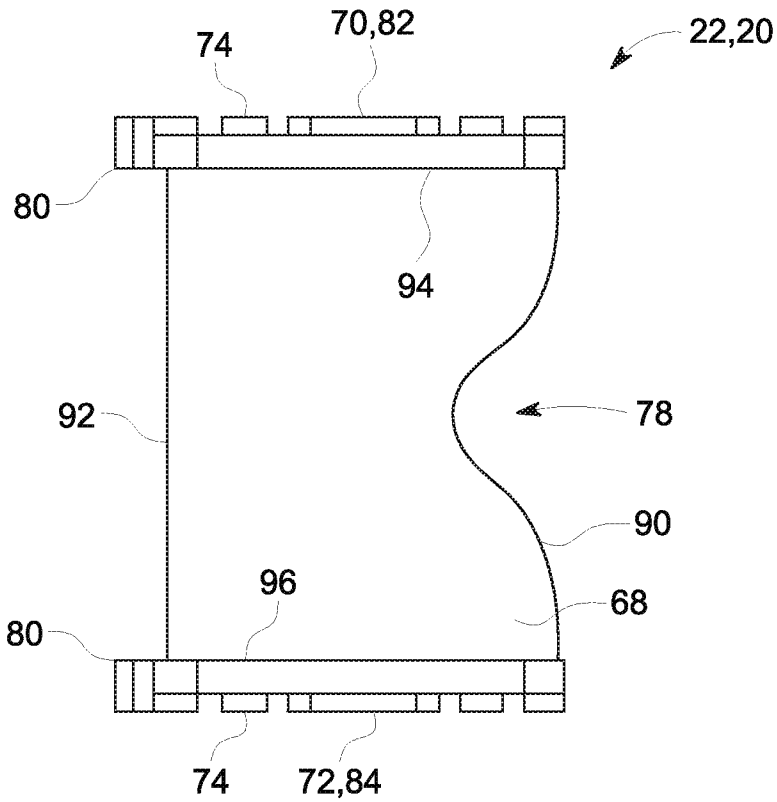


FIG. 5

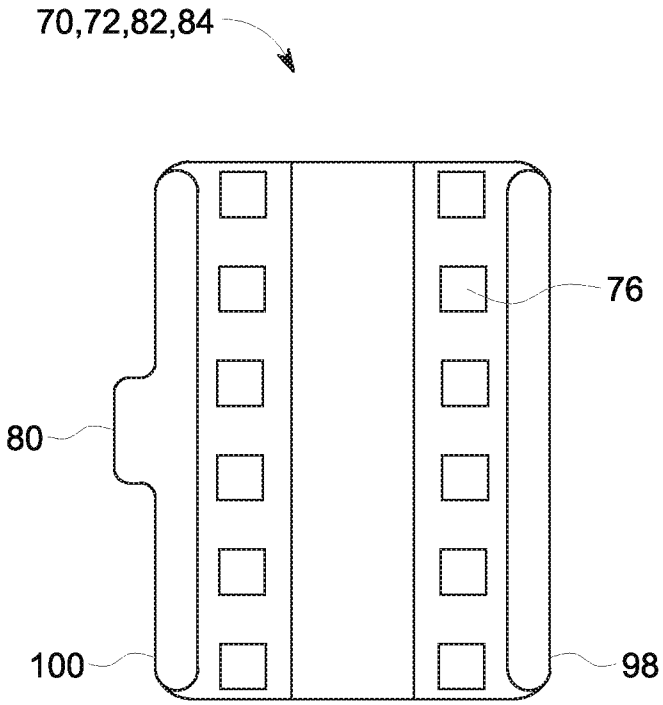


FIG. 6

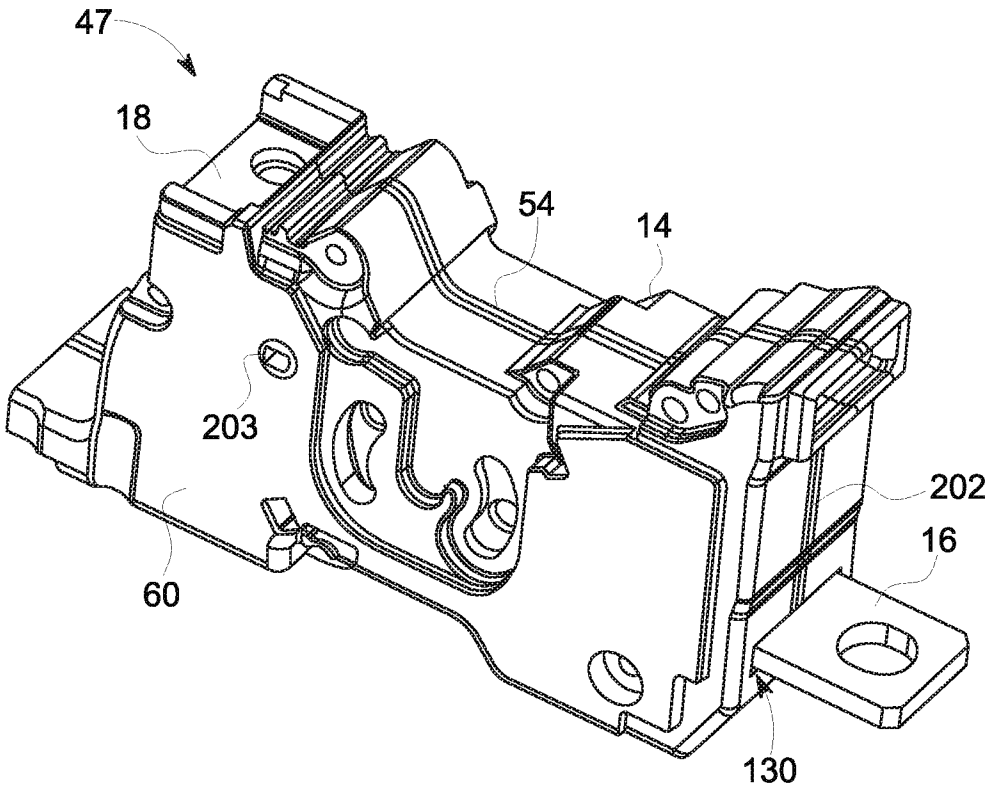


FIG. 7

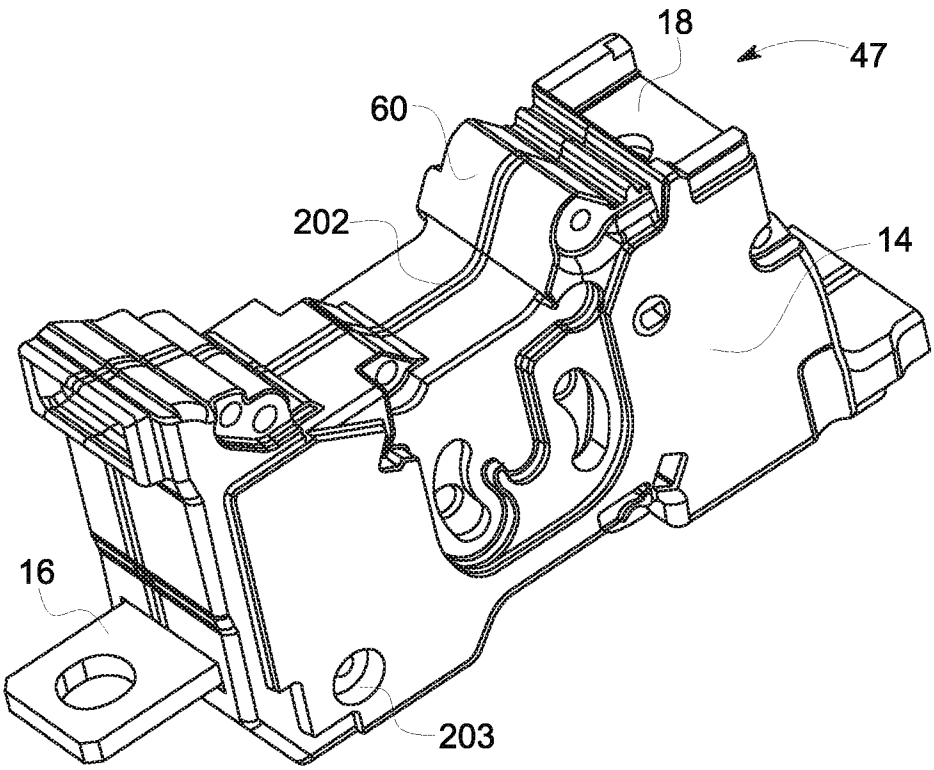


FIG. 8

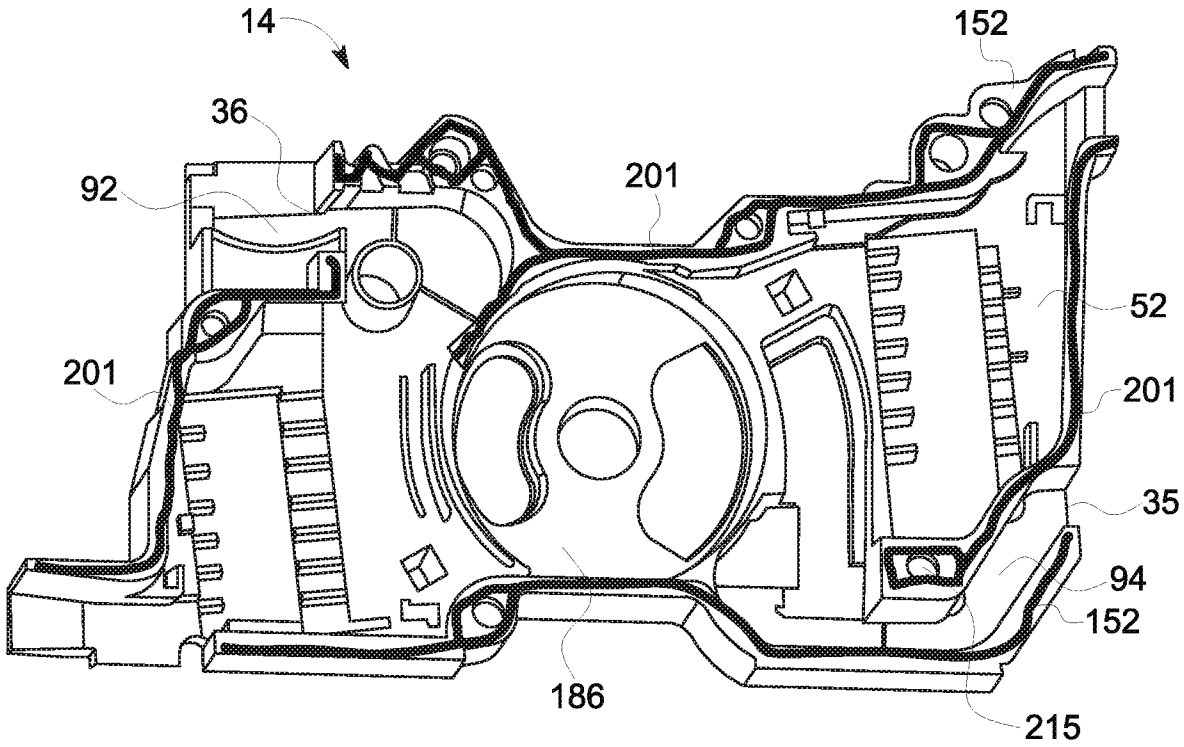


FIG. 9

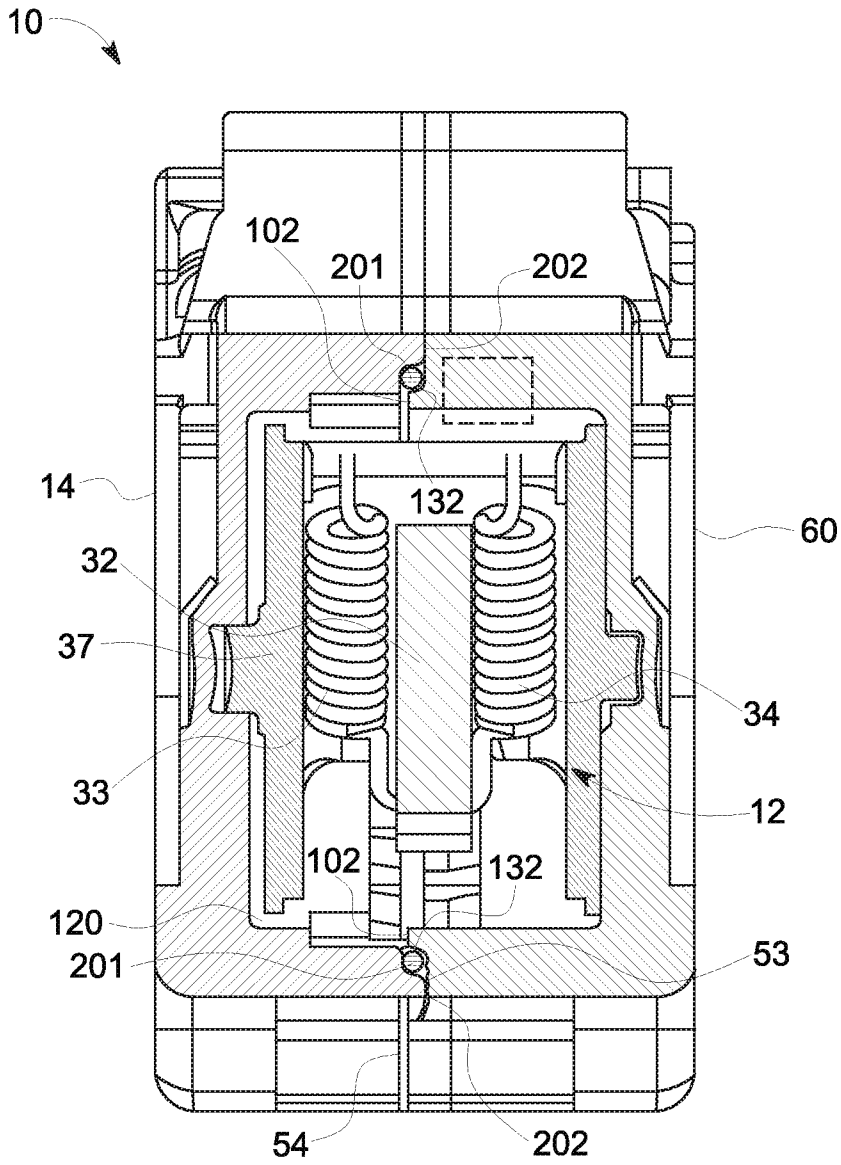


FIG. 10

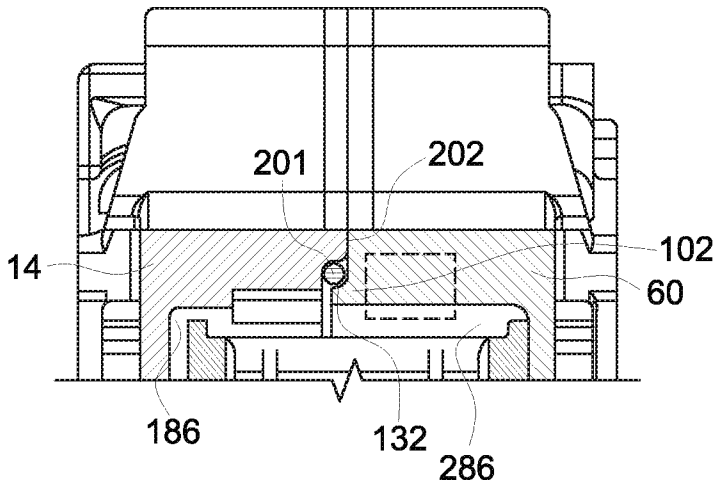


FIG. 11

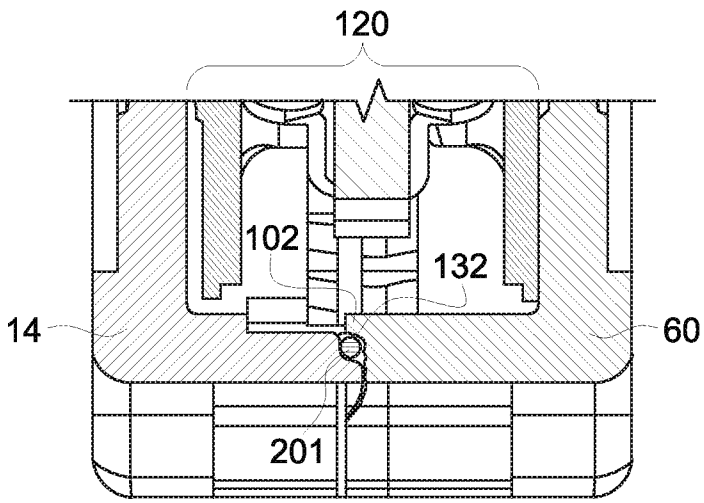


FIG. 12

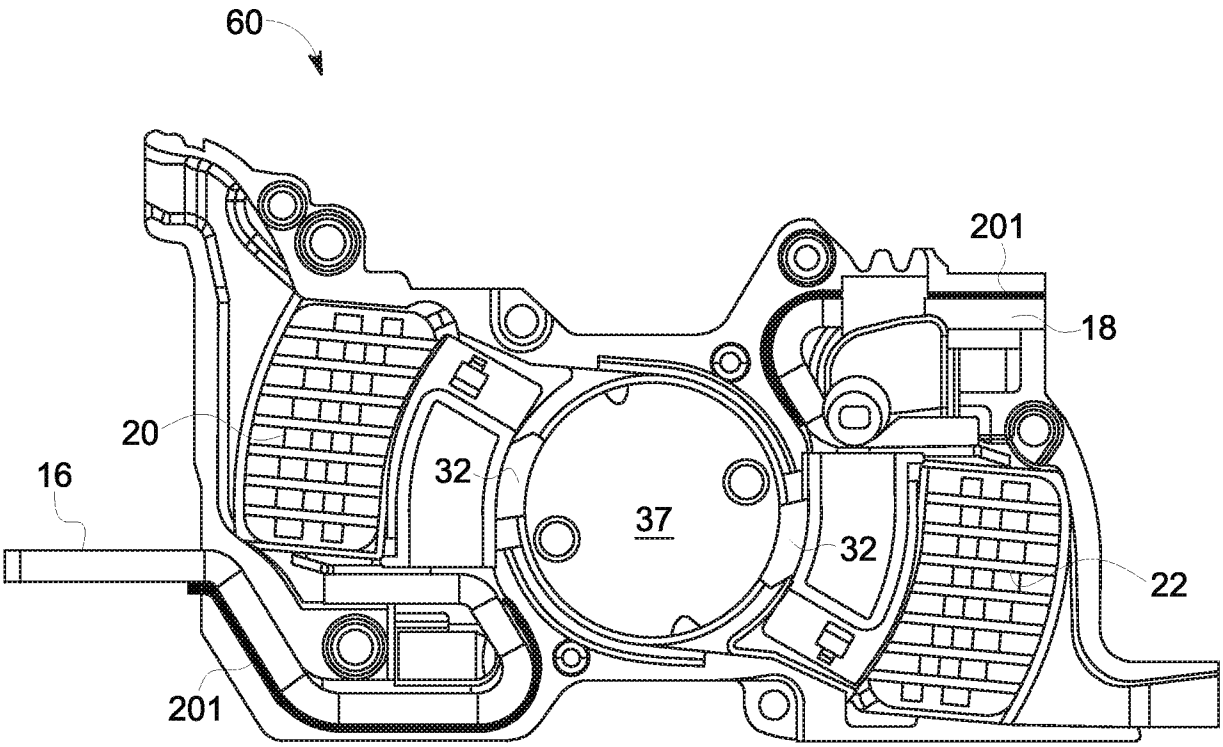


FIG. 13

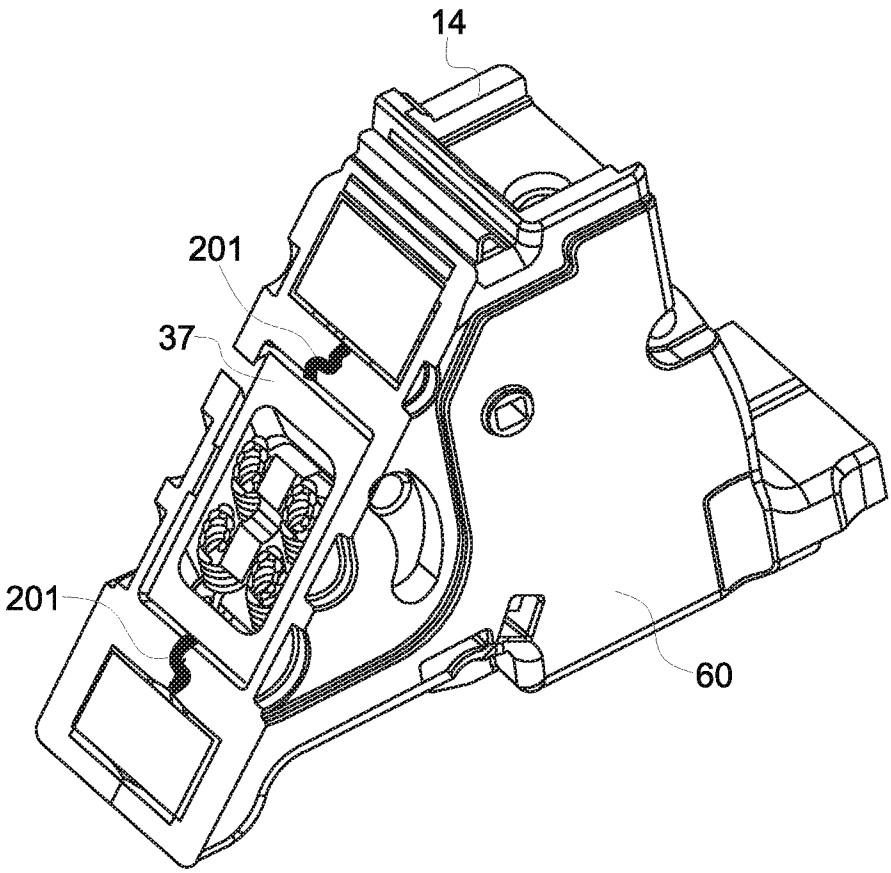


FIG. 14

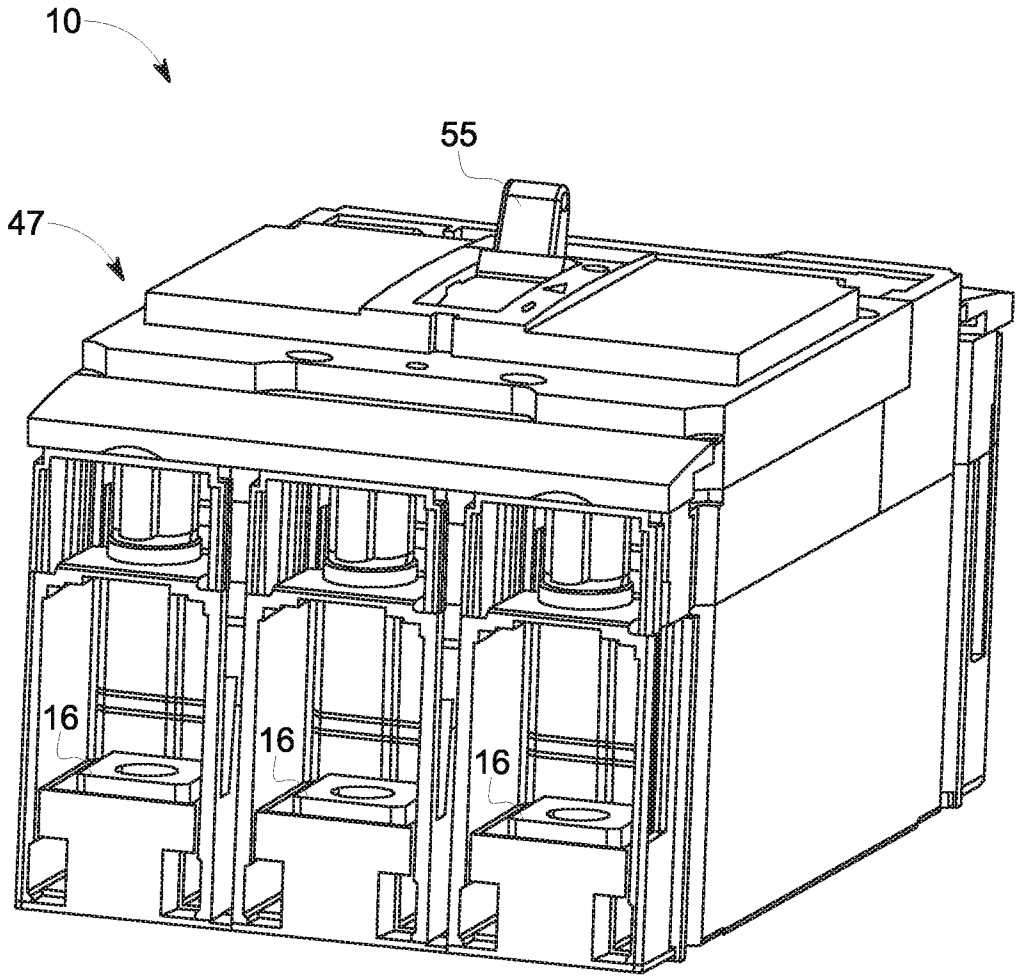


FIG. 15

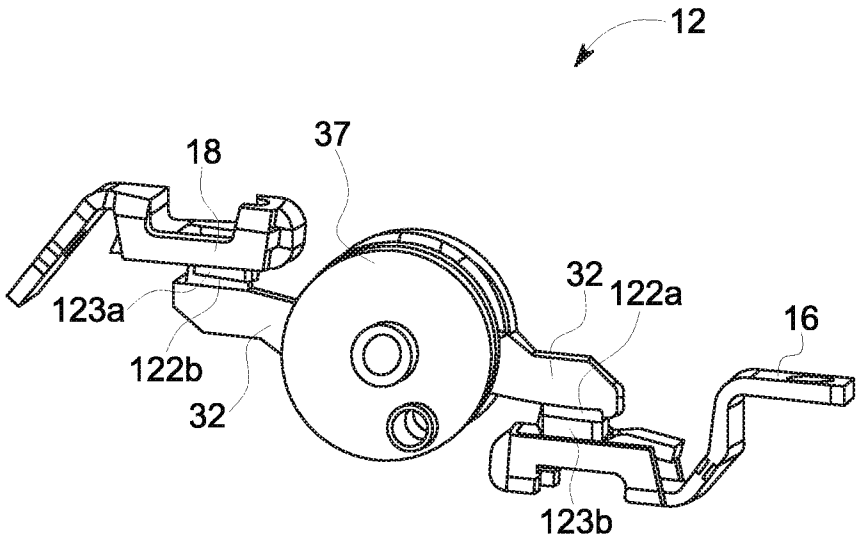


FIG. 16

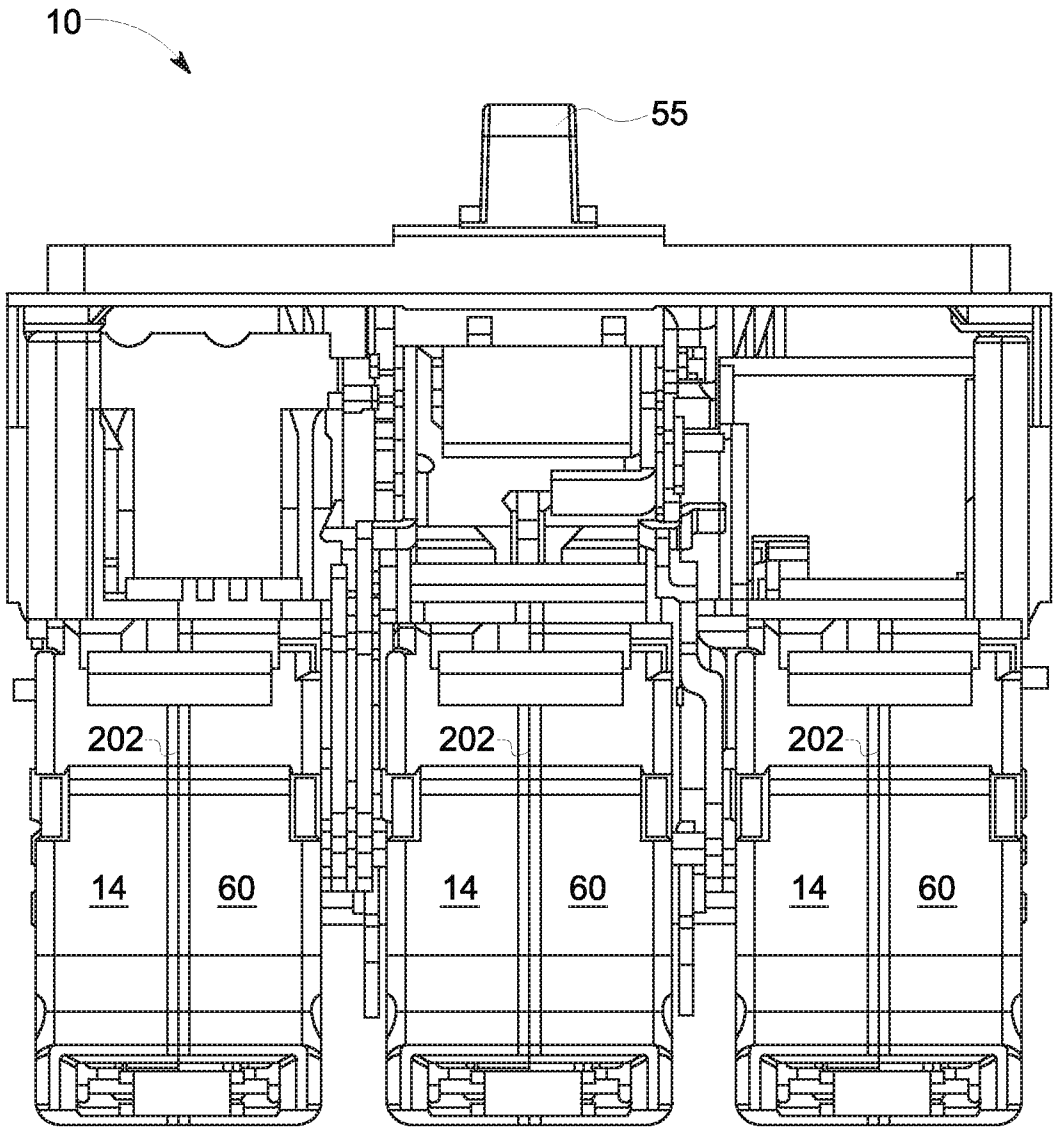


FIG. 17

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/021975

A. CLASSIFICATION OF SUBJECT MATTER
INV. H01H71/02
ADD. H01H73/04 H01H1/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	DE 10 2012 111391 A1 (STAHL SCHALTGERÄTE GMBH R [DE]) 28 May 2014 (2014-05-28) paragraphs [0015], [0027] - [0029]; figures 1,2	1,12 13,14 2-11
Y A	DE 77 13 388 U1 (LICENTIA PATENT-VERWALTUNGS-GMBH) 19 January 1978 (1978-01-19) page 3, lines 8-14; figures 1,2	13,14 1-12
A	US 6 239 398 B1 (DOUGHTY DENNIS J [US] ET AL) 29 May 2001 (2001-05-29) column 3, lines 41-65; figures 1-6	1-14

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 May 2016	15/06/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Glaman, C

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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