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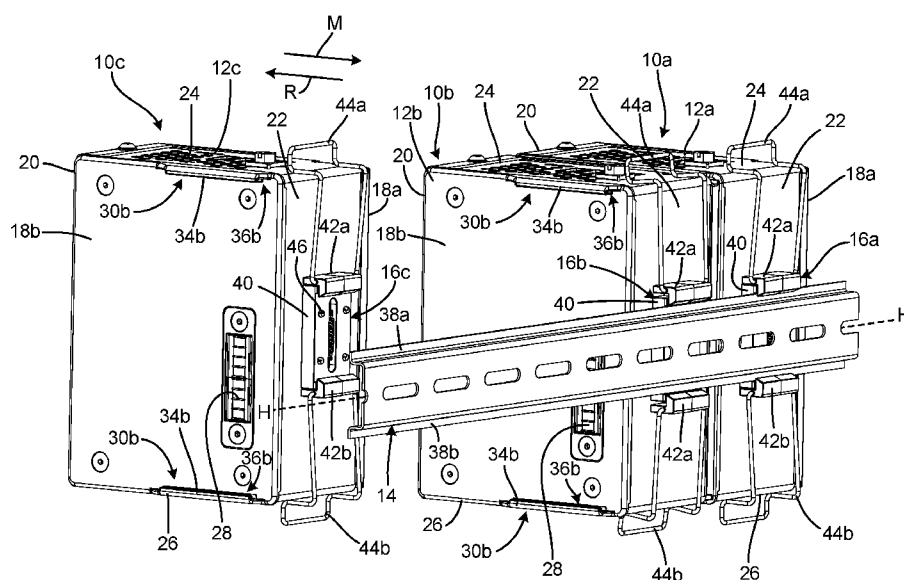


Fig. 1A

(57) Abstract: A mounting clamp (16) for mounting a control module (12) on a DIN rail (14) includes first and second retainers (42) configured to engage first and second flanges (38) of the DIN rail. An actuator (44) is connected to the first retainer to actuate the first retainer between an engaged state and a disengaged state. The mounting clamp facilitates mounting to and dismounting from the DIN rail in a linear direction (M, R) transverse to the elongate horizontal axis (H) of the DIN rail.

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DIN RAIL MOUNTING CLAMP

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application claims the benefit of U.S. Provisional Application No. 62/876,462
5 filed July 19, 2019 for “DIN RAIL MOUNTING CLAMP,” the disclosure of which is hereby incorporated by reference in its entirety.

BACKGROUND

This disclosure relates generally to clamps. More particularly, this disclosure relates to clamps for mounting modules on DIN rails.

10 DIN rails are metal rails to which circuit breakers and electronic control modules are mounted. The control modules can be communicatively connected by side contacts that need to mate with adjacent ones of the control modules. Adjacent control modules are connected via a locking interface to maintain the interface between the side contacts. Control modules can be mounted on the DIN rails utilizing clamps that are hooked over
15 one side of the rail and then pivoted into place to position the module. However, such mounting clamps cannot be used with configurations where the locking interface prohibits angular movement for mounting and dismounting of the control modules.

SUMMARY

According to one aspect of the disclosure, a mounting clamp for securing a module
20 to a DIN rail includes a clamp body; a first retainer spaced from the clamp body such that a first gap is formed between the first retainer and the clamp body; a second retainer spaced from the clamp body such that a second gap is formed between the second retainer and the clamp body; and a first actuator operatively connected to the first retainer. The first actuator is configured to actuate the first retainer between a engaged position, where the first gap is
25 closed by the first retainer to prevent lateral movement of a flange of a DIN rail out of the first gap away from the clamp body, and a disengaged position, where the first gap is open to allow lateral movement of the flange past the first retainer.

According to another aspect of the disclosure, a method includes shifting a control
module having a mounting clamp disposed on a mounting side of the control module in a
30 mounting direction towards a DIN rail, wherein the mounting direction is transverse to an elongate horizontal axis of the DIN rail; engaging a first retainer of the mounting clamp with a first flange of the DIN rail such that the first flange is secured in a first gap between the first retainer and a clamp body, and engaging a second retainer of the mounting clamp with a second flange of the DIN rail such that the second flange is secured in a second gap

between the second retainer and the clamp body, thereby mounting the control module to the DIN rail; actuating the first retainer from a engaged position to a disengaged position; and shifting the control module in a removal direction opposite the mounting direction removing the first flange from the first gap and removing the second flange from the second gap, thereby dismounting the control module from the DIN rail.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is a first isometric view of a mounting assembly.
 FIG. 1B is a second isometric view of a mounting assembly.
 FIG. 2A is an isometric view of a first clamp in a locked state.
 FIG. 2B is an isometric view of the first clamp in an unlocked state.
 FIG. 2C is an exploded view of the first clamp.
 FIG. 2D is a rear elevational view of a first clamp.
 FIG. 3 is a cross-sectional view of the first clamp taken along line 3-3 in FIG. 2A.
 FIG. 4A is an isometric view of a second clamp in a locked state and disposed on a DIN rail.
 FIG. 4B is a cross-sectional view taken along line B-B in FIG. 4A.
 FIG. 4C is a cross-sectional view taken along line C-C in FIG. 4B.
 FIG. 4D is a cross-sectional view taken along line D-D in FIG. 4B.
 FIG. 5A is an isometric view of a second clamp in an unlocked state.
 FIG. 5B is a cross-sectional view taken along line B-B in FIG. 5A showing the second clamp on a DIN rail.
 FIG. 5C is a cross-sectional view taken along line C-C in FIG. 5B showing the second clamp on a DIN rail.
 FIG. 5D is a cross-sectional view taken along line D-D in FIG. 5B showing the second clamp on a DIN rail.

DETAILED DESCRIPTION

FIG. 1A is a first isometric view of mounting assemblies 10a–10c and DIN rail 14. FIG. 1B is a second isometric view of mounting assemblies 10a–10c and DIN rail 14. Each mounting assembly 10a–10c includes, respectively, control module 12a–12c (collectively referred to as “control module 12” or “control modules 12”) and mounting clamp 16a–16c (collectively referred to as “mounting clamp 16” or “mounting clamps 16”). Each control module 12 includes lateral sides 18a, 18b; free side 20; mounting side 22; top 24; bottom 26; contacts 28, connectors 30a, 30b; and ports 32. Connectors 30a, 30b respectively include projections 34a, 34b and slots 36a, 36b. DIN rail 14 includes flanges 38a, 38b.

Each mounting clamp 16 includes clamp body 40; retainers 42a, 42b; and actuators 44a, 44b.

Control modules 12 are mounted adjacent each other to ensure contact between contacts 28 of the control modules 12. Control modules 12 are configured to provide commands and/or receive data from various components within a system, such as pumps, sprayers, and other components. For example, control modules 12 can be part of an industrial finishing system. Contacts 28 are exposed on each of lateral side 18a and lateral side 18b of each control module 12. With control modules 12 mounted on DIN rail 14, contacts 28 of adjacent ones of control modules 12 are aligned for communication. Ports 32 are disposed in free side 20 and top 24 of each control module 12. Ports 32 can also be formed in bottom 26 of control module 12. It is understood that ports 32 can be formed on any one or more of top 24, bottom 26, and free side 20. Ports 32 are configured to receive connectors, such as jacks, to provide power and communications directly to control module 12. For example, ports 32 can be configured for connections including Ethernet, high-definition multimedia interface (HDMI), universal serial bus (USB), among other options.

Connectors 30a are disposed on lateral side 18a of each control module 12, and connectors 30b are disposed on lateral side 18b of each control module 12. Each connector 30a includes projection 34a and slot 36a. Each connector 30b include projection 34b and slot 36b. Projections 34a, 34b are received by slots 36a, 36b when control modules 12 are assembled together adjacent each other. Projections 34a, 34b extend into slots 36a, 36b to limit relative movement between adjacent control modules 12 to linear movement towards and away from DIN rail. Projections 34a, 34b and slots 36a, 36b lock control modules 12 together such that adjacent control modules 12 cannot be pulled apart along the length of DIN rail 14 and cannot be rotated relative adjacent control modules 12. While connectors 30a, 30b are shown as including vertically extending projections 34a, 34b and slots 36a, 36b, it is understood that connectors 30a, 30b can be of any configuration suitable for locking adjacent control modules 12 together while preventing relative movement between the control modules 12.

In one example, connectors 30a, 30b limit relative movement of adjacent control modules 12 to linear movement perpendicular to the elongate horizontal axis H-H of DIN rail 14. In such an example, control module 12 can be mounted to DIN rail 14 by linear movement in the mounting direction M and can be removed from DIN rail 14 by linear movement in the removal direction R. Mounting direction M and removal direction R are opposite one another. Each of mounting direction M and removal direction R are transverse

to elongate horizontal axis H-H. In some examples, each of mounting direction M and removal direction R are perpendicular to elongate horizontal axis H-H.

Mounting clamp 16 is attached to mounting side 22 of control module 12. Mounting clamp 16 can be attached to mounting side 22 of control module 12 in any desired manner.

5 In one example, fasteners 46 extend through clamp body 40 and into control module 12. In other examples, clamp body 40 can be secured by control module 12 by gluing, welding, interfacing attachment features, or any other suitable manner. Retainers 42a, 42b are disposed at opposite ends of clamp body 40. Retainer 42a is disposed proximate a top of clamp body 40 and is configured to receive top flange 38 of DIN rail 14 between retainer
10 42a and clamp body 40. Retainer 42b is disposed proximate a bottom of clamp body 40 and is configured to receive bottom flange 38 of DIN rail 14 between retainer 42b and clamp body 40.

Actuator 44a extends from retainer 42a and is configured to be manipulated by a hand of a user. Actuator 44a extends over top 24 of control module 12 where actuator 44
15 is easily accessible by the user. Actuator 44b extends from retainer 42b and is configured to be manipulated by a hand of a user. Actuator 44b extends over bottom 26 of control module 12 where actuator 44b is easily accessible by the user. Actuators 44a, 44b are manipulated by the user to cause retainers 42a, 42b to shift from respective engaged positions to respective disengaged positions.

20 During operation, control modules 12 are mounted on DIN rail 14. In FIGS. 1A and 1B, control module 12a is disposed on DIN rail 14 with mounting clamp 16 in the locked state, control module 12b is disposed on DIN rail 14 with mounting clamp 16 in the unlocked state, and control module 12c is dismounted from DIN rail.

An example of mounting and dismounting a control module 12 is discussed in more
25 detail. To mount control module 12, control module 12 is shifted from the position of control module 12c and in mounting direction M towards DIN rail 14. As the control module 12 shifts towards DIN rail 14, connectors 30a on control module 12 encounter and interface with connectors 30b on an adjacent control module 12. The interface between connectors 30a and 30b align and guide control module 12 during mounting and lock
30 control module 12 to the adjacent control module 12. Projections 34a extend into slots 36b and projections 34b extend into slots 36a.

With connectors 30a, 30b interfacing together, the control module 12 continues to be shifted towards DIN rail 14 such that control module 12 is in the position of control module 12b. Mounting clamp 16 encounters DIN rail 14 and DIN rail 14 causes retainers

42a, 42b to shift from a normally-engaged position to a disengaged position, overcoming the force of a return mechanism maintaining the retainers 42a, 42b in the normally-engaged position and thereby allowing retainers 42a, 42b to respectively pass over flanges 38a, 38b. The return mechanism maintains the connectors 30a, 30b in the normally-engaged state to facilitate mounting clamp 16 locking on DIN rail 14. The return mechanism can be of any type suitable for maintaining connectors 30a, 30b in the normally-engaged state, such as a spring, a molded-in feature, or an elastic band, among other options. Once retainers 42a, 42b pass over flanges 38a, 38b, retainers 42a, 42b snap back to the normally-engaged position such that flange 38a is disposed between retainer 42a and clamp body 40 and flange 38b is disposed between retainer 42b and clamp body 40. Control module 12 is then in the position of control module 12a and is thereby mounted to DIN rail 14 for operation.

The control module 12 can be dismounted from DIN rail 14 in removal direction R. The control module 12 is initially in the state of control module 12a, where the control module 12 is mounted to DIN rail 14 and mounting clamp 16 is in the locked state. To dismount control module 12 from DIN rail 14, the user grasps and pulls actuators 44a, 44b. In the example shown, actuators 44a, 44b are pulled in removal direction R such that the force placed on actuators 44a, 44b to shift retainers 42a, 42b from the locked to unlocked states also assists in pulling of control module 12 off of DIN rail. Pulling actuators 44a, 44b causes retainers 42a, 42b to shift from the locked state to the unlocked state. Actuators 44a, 44b brace on top 24 and bottom 26 of control module 12, respectively. Actuators 44a, 44b bracing on control module 12 causes actuators 44a, 44b to impart a vertical force component on retainers 42a, 42b to pull retainers 42a, 42b into the unlocked state. After pulling actuators 44a, 44b the control module 12 is in the state of control module 12b, where the control module 12 is positioned on DIN rail 14, but mounting clamp 16 is unlocked.

With mounting clamp 16 in the unlocked state, the control module 12 can be pulled in removal direction R off of DIN rail 14. Connectors 30a, 30b slide within the interfacing ones of connectors 30b, 30a on adjacent control modules 12 as control module 12 is pulled in removal direction R. The control module 12 is then in the position of control module 12c where the control module 12 is fully dismounted from DIN rail 14. Actuators 44a, 44b can be released and the spring returns connectors 30a, 30b to the normally-engaged position.

Mounting assembly 10 provides significant advantages. Connectors 30a, 30b prevent relative movement between adjacent ones of control modules 12, ensuring that side contacts 28 are properly aligned with control modules 12 mounted on DIN rail 14.

Mounting clamp 16 allows for control modules 12 to be mounted and removed in directions perpendicular to elongate axis H-H of DIN rail 14. In addition, actuators 44a, 44b both facilitate unlocking of mounting clamp 16 and pulling of control module 12 off of DIN rail 14. The force exerted on actuators 44a, 44b to shift retainers 42a, 42b from the locked state to the unlocked state contains a force component in removal direction R, such that pulling actuators 44a, 44b to unlock retainers 42a, 42b can also pull control module 12 in removal direction R. As such, the user can simply pull actuators 44a, 44b to both unlock mounting clamp 16 and remove control module 12. In addition, control module 12 can be mounted to DIN rail 14 by simply pushing control module 12 in mounting direction M until mounting clamp 16 locks on DIN rail 14. Connectors 30a, 30b interface to prevent relative movement. Mounting control module 12 to DIN rail 14 does not require the user to make additional attachments between adjacent control modules 12 to ensure proper alignment. Mounting clamp 16 also facilitates tool-less installation and removal of control module 12.

FIG. 2A is an isometric view of mounting clamp 16 in a locked state. FIG. 2B is an isometric view of mounting clamp 16 in an unlocked state. FIG. 2C is an exploded view of mounting clamp 16. FIG. 2D is a rear elevation view of mounting clamp 16. FIGS. 2A–2D will be discussed together. Mounting clamp 16 includes clamp body 40; retainers 42a, 42b; actuators 44a, 44b; actuator spring 48; and receiving area 50. Clamp body 40 includes first end 52; second end 54; front side 56, back side 58, projections 60a, 60b; guide slot 62; spring slot 64; and fastener openings 66. Retainers 42a, 42b respectively include plates 68a, 68b; retaining members 70a, 70b; guide arms 72a, 72b; and spring mounts 74a, 74b. Plates 68a, 68b respectively include actuator openings 76a, 76b. Retaining members 70a, 70b respectively include sloped edges 78a, 78b. Actuators 44a, 44b respectively include prongs 80a, 80b, arms 82a, 82b, and handles 84a, 84b. Arms 82a, 82b respectively include vertical portions 86a, 86b and horizontal portions 88a, 88b.

Mounting clamp 16 is configured to facilitate linear, perpendicular mounting and dismounting of a control module, such as control modules 12a–12c (FIGS. 1A and 1B) on a DIN rail, such as DIN rail 14 (best seen in FIGS. 1A and 1B). Clamp body 40 is configured to be mounted to the body of a control module 12. For example, fasteners, such as fasteners 46 (FIG. 1A), can extend through fastener openings 66 in clamp body 40 and into the control module 12.

Guide slot 62 extends into back side 58 of clamp body 40 between first end 52 and second end 54. Guide slot 62 is elongate in the vertical direction and is configured to receive guide arms 72 of retainers 42a, 42b. Spring slot 64 extends through clamp body 40

between front side 56 and guide slot 62. Spring slot 64 is elongate between first side 52 and second side 54. Actuator spring 48 is disposed in spring slot 64 and is configured to maintain each retainer 42a, 42b in the locked state. Actuator spring 48 maintains each connector 30a, 30b in the normally-engaged state, which facilitates mounting of mounting
5 clamp 16 on DIN rail 14. While spring slot 64 is shown as exposed through front side 56 of clamp body 40, it is understood that spring slot 64 can be enclosed on front side 56. Projection 60a is disposed on front side 56 proximate first end 52. Similarly, projection 60b is disposed on front side 56 proximate second end 54. Projections 60a, 60b each project outward from front side 56. Receiving area 50 is formed adjacent front side 56 between
10 projection 60a and projection 60b.

Each retainer 42a, 42b is supported by clamp body 40. Plate 68a is disposed adjacent first end 52. Guide arm 72a extends from plate 68a and is disposed in guide slot 62. Guide arm 72a extends into guide slot 62 from first end 52. Guide arm 72a being disposed within guide slot 62 prevents undesired relative movement between retainer 42a
15 and clamp body 40. With mounting clamp 16 attached to control module 12, the body of control module 12 prevents guide arm 72a from exiting through the back side of guide slot 62. Guide slot 62 limits guide arm 72a, and thus retainer 42a, to vertical movement relative to clamp body 40. Spring mount 74a extends from guide arm 72 into spring slot 64. In the example shown, spring mount 74a is a hook configured to receive a loop on one end of
20 actuator spring 48. It is understood, however, that spring mount 74a can be of any desired configuration for connecting retainer 42a to actuator spring 48.

Retaining member 70a projects from plate 68a over projection 60a. With retainer 42a in the locked state, retaining member 70a extends beyond projection 60a and over receiving area 50. Sloped edge 78a is formed on the distal end of retaining member 70a
25 and faces outward relative to clamp body 40. Sloped edge 78a facilitates mounting of mounting clamp 16 on the DIN rail 14. Retaining member 70a can be considered a lip that extends around the free end of projection 60a to retain flange 38a between retainer 42a and clamp body 40.

In the example shown, retainer 42b is the same as retainer 42a, except retainer 42b
30 is disposed on second end 54 of clamp body 40. While retainers 42a, 42b are shown as having the same configuration, it is understood that retainers 42a, 42b can be of differing configurations without departing from the scope of this disclosure.

Plate 68b is disposed adjacent second end 54. Guide arm 72b extends from plate 68b and is disposed in guide slot 62. Guide arm 72b extends into guide slot 62 from second

end 54. Guide arm 72b being disposed within guide slot 62 prevents undesired relative movement between retainer 42b and clamp body 40. With mounting clamp 16 attached to control module 12, the body of control module 12 prevents guide arm 72b from exiting through the back side of guide slot 62. Guide slot 62 limits guide arm 72b, and thus retainer 42b, to vertical movement relative to clamp body 40. Spring mount 74b extends from guide arm 72 into spring slot 64. In the example shown, spring mount 74b is a hook configured to receive a loop on one end of actuator spring 48. It is understood, however, that spring mount 74b can be of any desired configuration for connecting retainer 42b to actuator spring 48. Actuator spring 48 is connected to each of connector 30a and connector 30b and pulls each connector 30a, 30b towards the locked, normally-engaged state. While mounting clamp 16 is shown as including actuator spring 48, it is understood that mounting clamp 16 can include a return mechanism of any desired type, such as a molded-in feature or an elastic band, among other options.

Retaining member 70b projects from plate 68b over projection 60b. With retainer 42b in the locked state, retaining member 70b extends beyond projection 60b and over receiving area 50. Sloped edge 78b is formed on the distal end of retaining member 70b and faces outward relative to clamp body 40. Sloped edge 78b facilitates mounting of mounting clamp 16 on the DIN rail 14. Retaining member 70b can be considered a lip that extends around the free end of projection 60b to retain flange 38b between retainer 42b and clamp body 40.

Actuator openings 76a are disposed on opposite lateral sides of plate 68a. Actuator openings 76a are configured to receive prongs 80a of actuator 44a. Prongs 80a extending into actuator openings 76a secures actuator 44a to retainer 42a to allow actuator 44a to actuate retainer 42a between the locked state and the unlocked state. Arms 82a project from prongs 80a to handle 84a. Vertical portions 86a of arms 82a are sized to extend beyond a top edge of a control module 12. Horizontal portions 88a extend from vertical portions 86a over the top edge. Handle 84a projects from the end of horizontal portions 88a opposite vertical portions 86a. Handle 84a provides a grasp point for a user to manipulate actuator 44a to actuate retainer 42a between the locked state and the unlocked state. The junction between horizontal portions 88a and handle 84a provides a contact point configured to contact the top side of control module 12 and brace against the top side to facilitate actuation of retainer 42a. Arms 82a can be of any desired length to extend beyond that top edge of control module 12. Actuators 44a of different lengths can be substituted

on a single mounting clamp 16 to allow the mounting clamp 16 to be utilized for mounting of control modules 12 of different sizes.

Actuator openings 76b are disposed on opposite lateral sides of plate 68b. Actuator openings 76b are configured to receive prongs 80b of actuator 44b. Prongs 80b extending
5 into actuator openings 76b secures actuator 44b to retainer 42b to allow actuator 44b to actuate retainer 42b between the locked state and the unlocked state. Arms 82b project from prongs 80b to handle 84b. Vertical portions 86b of arms 82b are sized to extend beyond a top edge of a control module 12. Horizontal portions 88b extend from vertical portions 86b over the top edge. Handle 84b projects from the end of horizontal portions
10 88b opposite vertical portions 86b. Handle 84b provides a grasp point for a user to manipulate actuator 44b to actuate retainer 42b between the locked state and the unlocked state. The junction between horizontal portions 88b and handle 84b provides a contact point configured to contact the bottom side of control module 12 and brace against the bottom side to facilitate actuation of retainer 42b. Arms 82b can be of any desired length
15 to extend beyond that top edge of control module 12. Actuators 44b of different lengths can be substituted on a single mounting clamp 16 to allow the mounting clamp 16 to be utilized for mounting of control modules 12 of different sizes.

Mounting clamp 16 facilitates lateral mounting and dismounting of a control module 12 on a DIN rail 14. To mount mounting clamp 16, mounting clamp 16 is shifted
20 towards DIN rail 14 with front side 56 facing DIN rail 14. Retaining members 70a, 70b initially encounter flanges 38a, 38b of DIN rail 14. Sloped edges 78a, 78b contact flanges 38a, 38b. As mounting clamp 16 is pushed onto DIN rail 14, flanges 38a, 38b cause retainers 42a, 42b to shift from the engaged position to the disengaged position due to flanges 38a, 38b interfacing with and acting on sloped edges 78a, 78b. Once retaining
25 members 70a, 70b pass over flanges 38a, 38b actuator spring 48 pulls each retainer 42a, 42b back to the engaged position such that mounting clamp 16 is in the locked state.

With mounting clamp 16 mounted on DIN rail 14, each of flanges 38a, 38b is disposed in receiving area 50. Flange 38a is retained between retaining member 70a and clamp body 40 and interfaces with a bottom side of projection 60a. Flange 38b is retained
30 between retaining member 70b and clamp body 40 and interfaces with a top side of projection 60b. Projections 60a, 60b are configured to receive the load of control module 12 mounted on DIN rail 14. In some examples, clamp body 40 supports control module 12 on DIN rail 14 while retainers 42a, 42b prevent control module 12 from pulling away from DIN rail 14.

To dismount mounting clamp 16, the user grasps handles 84a, 84b of actuators 44a, 44b and pulls handles 84a, 84b rearward away from DIN rail 14. Pulling handles 84a, 84b rearward causes the junction between horizontal portions 88a, 88b and handles 84a, 84b to contact the sides of control module 12, which imparts a vertical force component on retainers 42a, 42b. The vertical force component overcomes the force of actuator spring 48 and retainers 42a, 42b are pulled from the engaged positions to the disengaged positions. With retainers 42a, 42b in the disengaged positions, retaining members 70a, 70b do not cover and block removal of flanges 38a, 38b. Mounting clamp 16 can thus be pulled off of DIN rail 14 and control module 12 dismounted. It is understood that the user can impart a vertical force on retainers 42a, 42b in any desired manner. For example, the user can pull handles 84a, 84b in opposite vertical directions without bracing on control module 12, which would similarly cause retainers 42a, 42b to shift from respective engaged positions to respective disengaged positions.

Mounting clamp 16 provides significant advantages. During installation, sloped edges 78a, 78b encounter flanges 38a, 38b to cause retainers 42a, 42b to automatically shift from the engaged positions to the disengaged positions to receive flanges 38a, 38b. As such, the user is not required to manipulate retainers 42a, 42b during installation. Actuator spring 48 automatically returns retainers 42a, 42b to the engaged positions once retaining members 70a, 70b pass over flanges 38a, 38b. As such, the user does not need to perform any additional tasks to secure mounting clamp 16 to DIN rail 14. During removal, the user manipulates actuators 44a, 44b via handles 84a, 84b to impart a vertical force on retainers 42a, 42b. The vertical force overcomes the spring force of actuator spring 48 holding retainers 42a, 42b closed and retainers 42a, 42b shift to respective disengaged positions. With retainers 42a, 42b open, control module 12 can be pulled away from and off of DIN rail 14. As such, mounting clamp 16 facilitates simple, tool-less installation and removal of control modules 12 on DIN rails 14. Clamp body 40 bears the load when mounting clamp 16 is disposed on DIN rail 14. As such, clamp body 40 can be made from a more resilient material, such as metal, while other components of mounting clamp 16 can be made from a less resilient material, such as plastic. This reduces the overall cost of mounting clamp 16.

FIG. 3 is a cross-sectional view of mounting clamp 16 taken along line 3-3 in FIG. 2A. Mounting clamp 16 includes clamp body 40; retainers 42a, 42b; actuators 44a, 44b; actuator spring 48; and receiving area 50. Clamp body 40 includes first end 52; second end 54; front side 56, back side 58, projections 60a, 60b; guide slot 62; and spring slot 64.

Retainers 42a, 42b respectively include plates 68a, 68b; retaining members 70a, 70b; guide arms 72a, 72b; and spring mounts 74a, 74b. Retaining members 70a, 70b respectively include sloped edges 78a, 78b. Actuators 44a, 44b respectively include arms 82a, 82b and handles 84a, 84b. Arms 82a, 82b respectively include vertical portions 86a, 86b and
5 horizontal portions 88a, 88b.

Guide slot 62 extends through clamp body 40 between first end 52 and second end 54. Guide slot 62 is open on back side 58 of clamp body 40. Guide slot 62 is also open on first end 52 and second end 54 of clamp body 40. Spring slot 64 extends into clamp body 40 between front side 56 and guide slot 62. Spring slot 64 is elongate between first end 52
10 and second end 54 of clamp body 40 and is open through front side 56 and guide slot 62. It is understood, however, that spring slot 64 can be enclosed on front side 56. Actuator spring 48 is disposed in spring slot 64 and attached to retainers 42a, 42b at spring mounts 74a, 74b, respectively. Actuator spring 48 is configured to maintain retainers 42a, 42b in the engaged positions shown in FIG. 3.

15 Projection 60a extends from front side 56 of clamp body 40 proximate first end 52. Projection 60b extends from front side 56 of clamp body 40 proximate second end 54. Receiving area 50 is defined on front side 56 of clamp body 40 between the bottom edge of projection 60a and the top edge of projection 60b.

Retainers 42a, 42b are supported by clamp body 40. Guide arm 72a extends into
20 guide slot 62 from first end 52 of clamp body 40. Plate 68a is attached to guide arm 72a and extends over first end 52. Retaining member 70a extends from plate 68a over projection 60a. Sloped edge 78a is disposed at a distal end of retaining member 70a and is oriented away from clamp body 40. Sloped edge 78a facilitates mounting of mounting clamp 16 on a DIN rail, such as DIN rail 14 (best seen in FIGS. 1A and 1B). Gap 90a is
25 defined between retaining member 70a and front side 56 when retainer 42a is in the engaged position. Gap 90a is configured to receive a flange of DIN rail 14, such as flanges 38a, 38b (best seen in FIGS. 1A and 1B). With retainer 42a in the disengaged position, retaining member 70a is adjacent the outer edge of projection 60a such that retaining member 70a does not obstruct gap 90a. The flange can then slide past the lower edge of retaining
30 member 70a during dismounting.

Guide arm 72b extends into guide slot 62 from second end 54 of clamp body 40. Plate 68b is attached to guide arm 72b and extends over second end 54. Plate 68b is attached to guide arm 72b and extends over first end 52. Retaining member 70b extends from plate 68b over projection 60b. Sloped edge 78b is disposed at a distal end of retaining

member 70b and is oriented away from clamp body 40. Sloped edge 78b facilitates mounting of mounting clamp 16 on DIN rail 14. Gap 90b is defined between retaining member 70b and front side 56 when retainer 42b is in the engaged position. Gap 90b is configured to receive a flange of DIN rail 14, such as flanges 38a, 38b (best seen in FIGS. 1A and 1B). With retainer 42b in the disengaged position, retaining member 70b is adjacent the outer edge of projection 60b such that retaining member 70b does not obstruct gap 90b. The flange can then slide past the lower edge of retaining member 70b during dismounting.

Actuator 44a is attached to plate 68a. Actuator 44b is attached to plate 68b. Actuators 44a, 44b are configured to pull retainers 42a, 42b, respectively, from the engaged position to the disengaged position. To actuate retainers 42a, 42b to respective disengaged positions, actuators 44a, 44b impart a vertical force on retainers 42a, 42b, overcoming the force of actuator spring 48 and pulling retainers 42a, 42b away from each other. Pulling retainers 42a, 42b away from each other removes retaining members 70a, 70b from in front of gaps 90a, 90b, thereby allowing unobstructed movement of the flanges of the DIN rail 14 out of gaps 90a, 90b, thus allowing DIN rail 14 to be removed from receiving area 50.

FIG. 4A is an isomeric view of mounting clamp 16' in a locked state and disposed on DIN rail 14. FIG. 4B is a cross-sectional view taken along line B-B in FIG. 4A. FIG. 4C is a cross-sectional view taken along line C-C in FIG. 4A. FIG. 4D is a cross-sectional view taken along line D-D in FIG. 4A. FIG. 5A is an isometric view of mounting clamp 16' in an unlocked state and disposed on DIN rail 14. FIG. 5B is a cross-sectional view taken along line B-B in FIG. 5A. FIG. 5C is a cross-sectional view taken along line C-C in FIG. 5A. FIG. 5D is a cross-sectional view taken along line D-D in FIG. 5A. FIGS. 4A–5D will be discussed together.

Mounting clamp 16' includes clamp body 40', retainer 42a', retainers 42b', actuator 44', actuator spring 48', and receiving area 50. Clamp body 40' includes first end 52'; second end 54'; front side 56'; back side 58'; projections 60a', 60b'; fastener openings 66; actuator bore 92; guide bores 94; and retainer bores 96. Actuator bore 92 includes first diameter portion 98 and second diameter portion 100. Retainer 42a' includes plate 68' and retaining members 70a'. Plate 68' includes plate bore 102. Each retainer 42b' includes retaining member 70b' and retainer spring 104. Actuator 44' includes head 106, shaft 108, shoulder 110, and connecting portion 112. DIN rail 14 includes flanges 38a, 38b.

Mounting clamp 16' facilitates lateral, perpendicular mounting and dismounting of control modules, such as control modules 12a–12c (FIGS. 1A–1C), on DIN rail 14. Clamp body 40' is configured to be mounted to a body of the control module 12. For example,

fasteners, such as fasteners 46 (FIG. 1A), can extend through fastener openings 66 and into the control module 12. Clamp body 40' supports the load of the control module when mounted on DIN rail 14.

Projection 60a' is disposed on front side 56' of clamp body 40' proximate first end 52'. Projection 60b' is disposed on front side 56' of clamp body 40' proximate second end 54'. Each of projections 60a', 60b' extend outward from front side 56'. Receiving area 50, which is the area of mounting clamp 16' configured to receive DIN rail 14, is defined on front side 56' between projection 60a' and projection 60b'. Flanges 38a, 38b contact inner sides of projections 60a', 60b', respectively, when mounting clamp 16' is disposed on DIN rail 14 such that projections 60a', 60b' receive the load.

Actuator bore 92 extends vertically through clamp body 40' from first end 52' to second end 54'. First diameter portion 98 of actuator bore 92 has a larger diameter than second diameter portion 100. First diameter portion 98 extends from second end 54' into clamp body 40'. Second diameter portion 100 extends from first diameter portion 98 to first end 52' of clamp body 40'. It is understood, however, that first diameter portion 98 can extend from first end 52' and second diameter portion 100 can extend from second end 54', such as in examples with retainer 42a' disposed at second end 54' and retainers 42b' disposed at first end 52'.

Actuator 44' extends through actuator bore 92 and projects out each end of actuator bore 92 beyond each of first end 52' and second end 54'. More specifically, shaft 108 of actuator 44' extends through actuator bore 92. Head 106 is disposed at a first end of shaft 108 and is configured to be manipulated by a hand of the user. Connecting portion 112 is disposed at a second end of shaft 108 and is configured to connect with plate 68' of retainer 42a'. For example, connecting portion 112 can include external threading configured to mate with internal threading within plate bore 102. It is understood, however, that connecting portion 112 can be secured to plate 68' in any desired manner, either permanently or removably. For example, connecting portion 112 can be press-fit into plate bore 102, can be glued to plate 68', can be welded to plate 68', can be integrally formed with plate 68', or can be secured to plate 68' in any other suitable manner. Shoulder 110 is formed on shaft 108 between head 106 and connecting portion 112. The portion of shaft 108 between shoulder 110 and connecting portion 112 has a smaller diameter than the portion of shaft 108 between shoulder 110 and head 106. Actuator spring 48' is disposed in actuator bore 92 about shaft 108. Actuator spring 48' interfaces with shoulder 110 and clamp body 40' and is configured to bias actuator 44', and thus retainer 42a' due to the

connection of actuator 44' and retainer 42a', towards the engaged position shown in FIGS. 4A–4D. Actuator spring 48' maintains retainer 42a' in the normally-engaged position, thereby facilitating mounting of mounting clamp 16' on DIN rail 14. While mounting clamp 16' is shown as including actuator spring 48', it is understood that mounting clamp 16' can include a return mechanism of any desired type, such as a molded-in feature or an elastic band, among other options.

Retainer 42a' is disposed on first end 52' of clamp body 40' and at least a portion of retainer 42a' extends through clamp body 40'. Plate 68' is disposed on first end 52'. Retaining members 70a' project from plate 68' and are disposed at least partially within guide bores 94 through projection 60a' with retainer 42a' in both the disengaged position and the engaged position. Retaining members 70a' can be secured to plate in any desired manner. For example, retaining members 70a' and plate 68' can include interfaced threading, retaining members 70a' can be press-fit into plate 68', retaining members 70a' can be glued to plate 68', retaining members 70a' can be integrally formed with plate 68', or retaining members 70a' can be secured to plate 68' in any other suitable manner. While retainer 42a' is shown as including two retaining members 70a', it is understood that retainer 42a' can include as many or as few retaining members 70a' as desired, such as one, three, four, or more retaining members 70a'. In the example shown, retaining members 70a' include pins extending from plate 68'. It is understood, however, that retaining members 70a' can be formed from any type of projection capable of being selectively positioned to retain flange 38a and release flange 38a from between the retaining members 70a' and clamp body 40'. For example, retainer 42a' can include a flange projecting through a slot, can extend over a free end of projection 60a', similar to retaining members 70a, 70b (FIGS. 2A–3), or be of any other form suitable for retaining and releasing flange 38a.

Gap 90a is defined between retaining members 70a' and clamp body 40' when retainer 42a' is in the engaged position. Gap 90a is configured to receive flange 38a of DIN rail 14 when mounting clamp 16' is mounted on DIN rail 14. With retainer 42a' in the disengaged position, retaining members 70a' are retracted into guide bores 94 such that retaining members 70a' do not obstruct gap 90a. Flange 38a can then slide past the distal ends of retaining members 70a' during mounting and dismounting.

Retainer bores 96 extend vertically through projection 60b'. Retainers 42b' are disposed at least partially within retainer bores 96 and are configured to project out of retainer bores 96 proximate receiving area 50. Retainer springs 104 are disposed in retainer bores 96. Retaining members 70b' are disposed at the inner edge of projection 60b' and at

least partially project out of retainer bores 96 over receiving area 50. Retainer springs 104 bias retaining members 70b' out of retainer bores 96 but are compressible to allow retaining members 70b' to be pushed into retainer bores 96 as DIN rail 14 passes over retainers 42b'. The surface of each retaining member 70b' is profiled such that flange 38b of DIN rail 14 can impart a vertical force on retaining member 70b' to cause retaining member 70b' to retract within retainer bore 96 as flange 38b contacts and then passes over retaining member 70b' during mounting and dismounting of mounting clamp 16' on DIN rail 14. In the example show, retaining members 70b' are balls. As such, retainers 42b' can be considered as ball detents. It is understood, however, that retaining members 70b' can have any surface profile suitable for compressing in response to flange 38b passing over retaining member 70b' in either the mounting direction M or the removal direction R. For example, retaining member 70b' can have ramped faces, be hemispherical, be frustoconical, or be of any other suitable configuration. While mounting clamp 16' is shown as including two retainers 42b', it is understood that mounting clamp 16' can include as many or as few retainers 42b' as desired, such as one, three, four, or any other desired number.

Gap 90b is defined between retaining members 70b' and clamp body 40'. Gap 90b is configured to receive flange 38b of DIN rail 14 when mounting clamp 16' is mounted on DIN rail 14. As discussed above, retaining members 70b' are configured to retract within retainer bores 96 in response to flange 38b contacting and then passing over retainers 42b' during mounting and dismounting.

Mounting clamp 16' facilitates linear, perpendicular mounting of control modules 12 on DIN rail 14. Mounting clamp 16' is initially in the locked state, shown in FIGS. 4A–4D. The user depresses actuator 44' such that actuator 44' lifts retainer 42a' off of first end 52', driving retainer 42a' to the disengaged position and placing mounting clamp 16' in the unlocked state, both shown in FIGS. 5A–5C. For example, the user can push on head 106 of actuator 44' to depress actuator 44' within actuator bore 92. Depressing actuator 44' compresses actuator spring 48' within actuator bore 92.

With mounting clamp 16' in the unlocked state, the user shifts mounting clamp 16' linearly towards DIN rail 14 in mounting direction M. Flange 38b encounters retaining members 70b' of retainers 42b'. The user continues to shift mounting clamp 16' towards DIN rail 14 and flange 38b causes retaining members 70b' to compress within retainer bores 96. Flange 38b passes over retaining members 70b' and enters gap 90b. Retainer springs 104 push retaining members 70b' back such that retaining members 70b' project in front of flange 38b and close gap 90b. Retaining members 70b' retain flange 38b within gap 90b.

Flange 38a is disposed in gap 90 when flange 38b disposed in gap 90b. Mounting clamp 16' is thus positioned on DIN rail 14.

The user releases actuator 44' and actuator spring 48' drives actuator 44', and thus retainer 42a', from the disengaged positions shown in FIGS. 5A–5D to the locked positions shown in FIGS. 4A–4D. Retaining members 70a' extend out of guide bores 94 closing gap 90a and retaining flange 38a between retaining members 70a'a and clamp body 40'. With gap 90a closed by retaining members 70a' and gap 90b closed by retaining members 70b', mounting clamp 16' is secured to DIN rail 14. Flanges 38a, 38b contact the inner sides of projections 60a', 60b', respectively, such that clamp body 40' takes the load when mounting clamp 16' is mounted to DIN rail 14. Retaining members 70a' are sized to project over flange 38a such that mounting clamp 16' cannot be rotated relative to DIN rail 14. As such, retaining members 70a' prevent flange 38b from passing over retainers 42b' unless mounting clamp 16' is in the unlocked state.

To dismount mounting clamp 16' from DIN rail 14, the user depresses actuator 44' such that actuator 44' lifts retainer 42a' off of first end 52', driving retainer 42a' to the disengaged position and placing mounting clamp 16' in the unlocked state. Retainer 42a' shifting to the disengaged position removes retaining members 70a' from in front of flange 38a, such that gap 90a are open. With gap 90a open, flange 38a can pass below retaining members 70a' and out of gap 90a.

The user pulls mounting clamp 16' in removal direction R. Flange 38b encounters retaining members 70b' and causes retaining members 70b' to retract within retainer bores 96. Flange 38b passes over retaining members 70b' as the user pulls mounting clamp 16' in removal direction R. After flanges 38a, 38b pass out of gap 90a, 90b, respectively, mounting clamp 16' is dismounted from DIN rail 14. With mounting clamp 16' removed from DIN rail 14, the user releases actuator 44' and actuator spring 48' drives actuator 44', and thus retainer 42a', back to their respective engaged positions shown in FIGS. 4A–4D.

Mounting clamp 16' can be mounted to and dismounted from DIN rail 14 by two transverse motions. The first motion includes driving retainer 42a' from the engaged position to the disengaged position, such as by pushing actuator 44'. The second motion includes pushing mounting clamp 16' onto DIN rail 14 or pulling mounting clamp 16' off of DIN rail 14. In some examples, the first motion and the second motion can be perpendicular. While mounting clamp 16' is described as having retainer 42a' and retainers 42b' of differing configurations, it is understood that each retainer 42a', 42b' can be of the same configuration. For example, mounting clamp 16' can include a first retainer 42a' on

first end 52' and a second retainer 42a' on second end 54' with first and second actuators 44' connected to each. The user can depress each of the first and second actuators 44' to actuate the first and second retainers 42a' between respective open and engaged positions.

5 Mounting clamp 16' provides significant advantages. Retainers 42b' are configured to automatically retract as flange 38b passes over retainers 42b'. Retainer springs 104 return retaining members 70b' to the engaged position once flange 38b is positioned in gap 90b. As such retainer 42b' does not require additional manipulation to receive flange 38b. Actuator spring 48' automatically return retainer 42a' to the engaged position when actuator 44' is released. As such, the user does not need to perform additional tasks to secure
10 mounting clamp 16' to DIN rail 14 besides depressing and releasing actuator 44'. Mounting clamp 16' can be mounted to DIN rail 14 by two transverse motions, actuating retainer 42a' open and shifting mounting clamp on to DIN rail 14. Such a mounting arrangement reduces mounting time and complexity. Clamp body 40' bears the load when mounting clamp 16' is disposed on DIN rail 14. As such, clamp body 40' can be made from a more resilient
15 materials, such as metal, while other components of mounting clamp 16' can be made from less resilient materials, such as plastic. This reduces the overall cost of mounting clamp 16'. Mounting clamp 16' facilitates simple, tool-less installation and removal of control modules 12 on DIN rails 14.

While the invention has been described with reference to an exemplary
20 embodiment(s), 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
25 particular embodiment(s) disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

CLAIMS:

1. A mounting clamp for securing a module to a DIN rail having first and second flanges extending radially relative to an elongate axis of the DIN rail, the mounting clamp comprising:
 - 5 a clamp body;
 - a first retainer spaced from the clamp body such that a first gap is formed between the first retainer and the clamp body;
 - a second retainer spaced from the clamp body such that a second gap is formed between the second retainer and the clamp body; and
 - 10 a first actuator operatively connected to the first retainer;wherein the first actuator is configured to actuate the first retainer between a engaged position, where the first gap is closed by the first retainer to prevent lateral movement of the first flange of the DIN rail out of the first gap away from the clamp body, and a disengaged position,
 - 15 where the first gap is open to allow lateral movement of the first flange past the first retainer.
2. The mounting clamp of claim 1, further comprising:
 - a return mechanism configured to bias the first retainer towards the engaged position.
- 20 3. The mounting clamp of any one of claims 1 and 2, wherein the clamp body comprises:
 - a first side, a second side, a front side, and a back side;
 - a first projection extending from the front side proximate the first side;
 - a second projection extending from the front side proximate the back side;
 - 25 wherein a receiving area is defined between the first projection and the second projection, the receiving area configured to receive at least a portion of the DIN rail.
4. The mounting clamp of claim 3, wherein the first retainer includes a plate disposed adjacent the top side with the first retainer in the engaged position and spaced
 - 30 from the top side with the first retainer in the disengaged position.
5. The mounting clamp of any one of claims 1 and 2, further comprising:
 - a second actuator operatively connected to the second retainer, wherein the second actuator is configured to actuate the second retainer between a engaged position, where the second gap is closed by the second

retainer to prevent lateral movement of the second flange of a DIN rail out of the second gap away from the clamp body, and a disengaged position, where the second gap is open to allow lateral movement of the second flange past the first retainer.

5 6. The mounting clamp of claim 1, wherein the first retainer includes a first retaining member and the first gap is defined between the clamp body and the first retaining member, and wherein the second retainer includes a second retaining member and the second gap is defined between the clamp body and the second retaining member.

7. The mounting clamp of claim 6, wherein:
10 the first retainer includes a first plate disposed adjacent a first end of the clamp body; and
 the first retaining member extends from the first plate and projects over a first free end of a first projection extending from a front side of the clamp body.

15 8. The mounting clamp of claim 7, wherein the first retaining member includes a first sloped edge at an end of the first retaining member opposite the plate.

9. The mounting clamp of claim 7, the actuator comprising:
 a prong disposed at a first end of the actuator and extending into the plate;
 a handle disposed at a second end of the actuator opposite the first end; and
20 an arm extending between the prong and the handle.

10. The mounting clamp of claim 7, further comprising:
 a second actuator operatively connected to the second retainer and configured to actuate the second retainer between a engaged position and a disengaged position.;

25 wherein the second retainer includes a second plate disposed adjacent a second side of the clamp body; and
 wherein the second retaining member extends from the second plate and projects over a second free end of a second projection extending from the front side of the clamp body.

30 11. The mounting claim of claim 10, wherein:
 the clamp body includes a guide slot extending between the first side and the second side;
 the first retainer includes a first guide arm projecting from the first plate and into the guide slot; and

the second retainer includes a second guide arm projecting from the second plate and into the guide slot.

12. The mounting clamp of claim 11, wherein the clamp body further comprises:

5 a spring slot elongate between the first end and the second end;
wherein the return mechanism is an actuator spring disposed in the spring slot and connected to each of the first retainer and the second retainer, the actuator spring configured to bias each of the first retainer and the second retainer towards respective engaged
10 positions.

13. The mounting clamp of claim 12, wherein:
the first guide arm includes a first spring mount projecting from the first guide arm into the spring slot;
the second guide arm includes a second spring mount projecting from the
15 second guide arm into the spring slot; and
the spring is attached to each of the first spring mount and the second spring mount.

14. The mounting claim of claim 6, wherein:
the first retainer includes a plate disposed adjacent a first end of the clamp
20 body; and
at least one retaining member extends from the plate through at least one opening in a first projection extending from a front side of the clamp body.

15. The mounting clamp of claim 14, wherein the at least one retaining member
25 is a pin.

16. The mounting clamp of claim 14, wherein:
the actuator includes a shaft extending through an actuator bore in the clamp body between the first end and a second end;
the shaft extends out of the actuator bore beyond the first side and the second
30 side;
the shaft is connected to the plate; and
the return mechanism is an actuator spring disposed within the actuator bore and interfacing with the shaft, the actuator spring configured to bias the actuator towards the second side.

17. The mounting clamp of any one of claims 14–16, wherein the second retainer comprises:

a second retaining member at least partially disposed within a retainer bore within a second projection extending from the front side of the clamp body; and

a retainer spring disposed within the retainer bore to bias the second retaining member into a receiving area defined between the first projection and the second projection.

18. The mounting clamp of claim 17, wherein the retaining member is a ball.

10 19. An assembly comprising:

a control module having a first lateral side, a second lateral side, a contact on at least one of the first lateral side and the second lateral side, a first connecting feature formed on the first lateral side, and a second connecting feature formed on the second lateral side; and

15 the mounting clamp of any preceding claim attached to the control module and configured to mount the control module to the DIN rail;

wherein the first connecting feature and the second connecting feature limit movement of the control module relative to an adjacent control module to perpendicular movement relative to an elongate direction of the DIN rail.

20 20. A method comprising:

shifting a control module having a mounting clamp disposed on a mounting side of the control module in a mounting direction towards a DIN rail, wherein the mounting direction is transverse to an elongate horizontal axis of the DIN rail;

25 engaging a first retainer of the mounting clamp with a first flange of the DIN rail such that the first flange is secured in a first gap between the first retainer and a clamp body, and engaging a second retainer of the mounting clamp with a second flange of the DIN rail such that the second flange is secured in a second gap between the second retainer and the clamp body, thereby mounting the control module to the DIN rail;

30 actuating the first retainer from an engaged position to a disengaged position; and

shifting the control module in a removal direction opposite the mounting direction removing the first flange from the first gap and removing the second flange from the second gap, thereby dismounting the control module from the DIN rail.

5

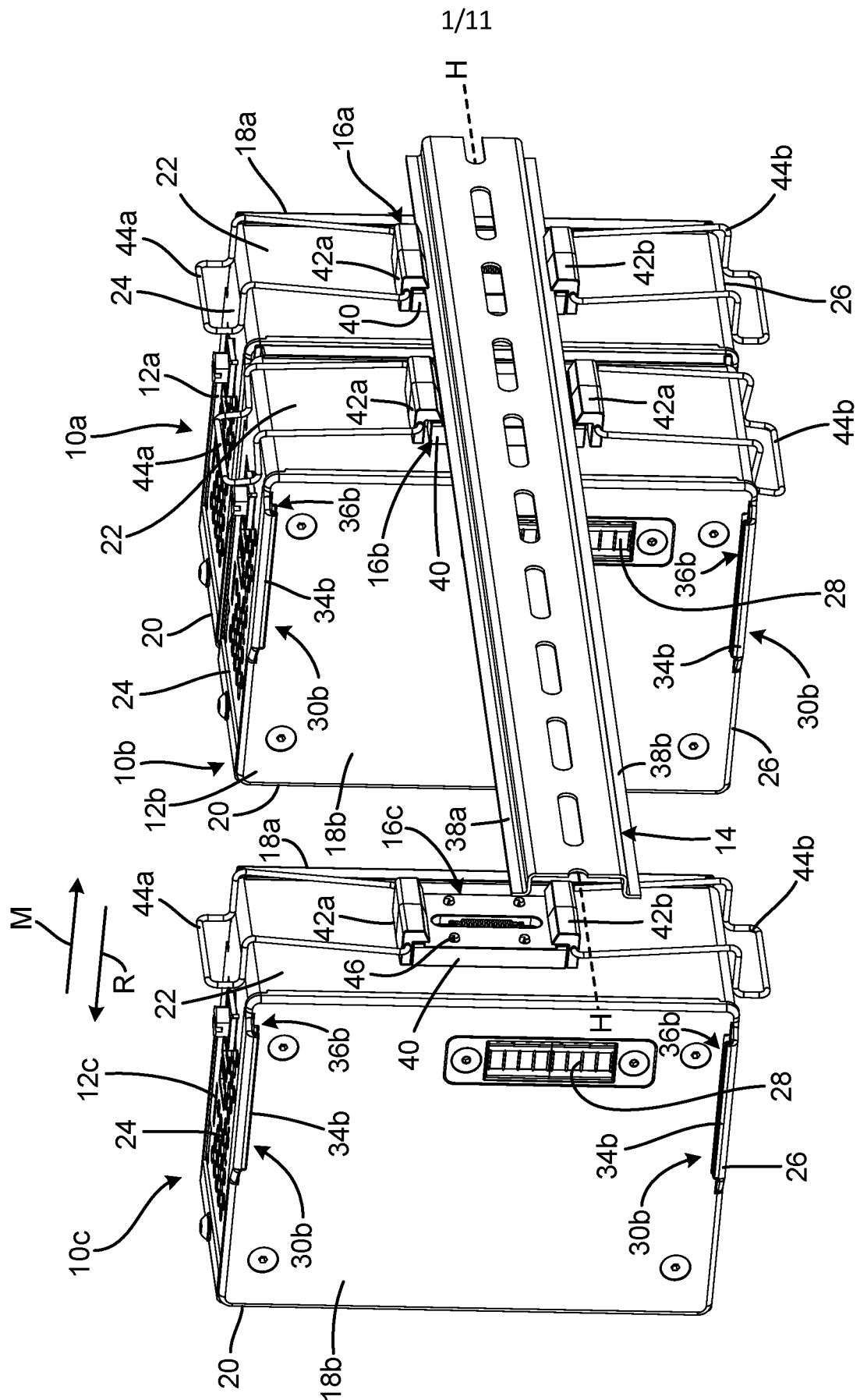


Fig. 1A

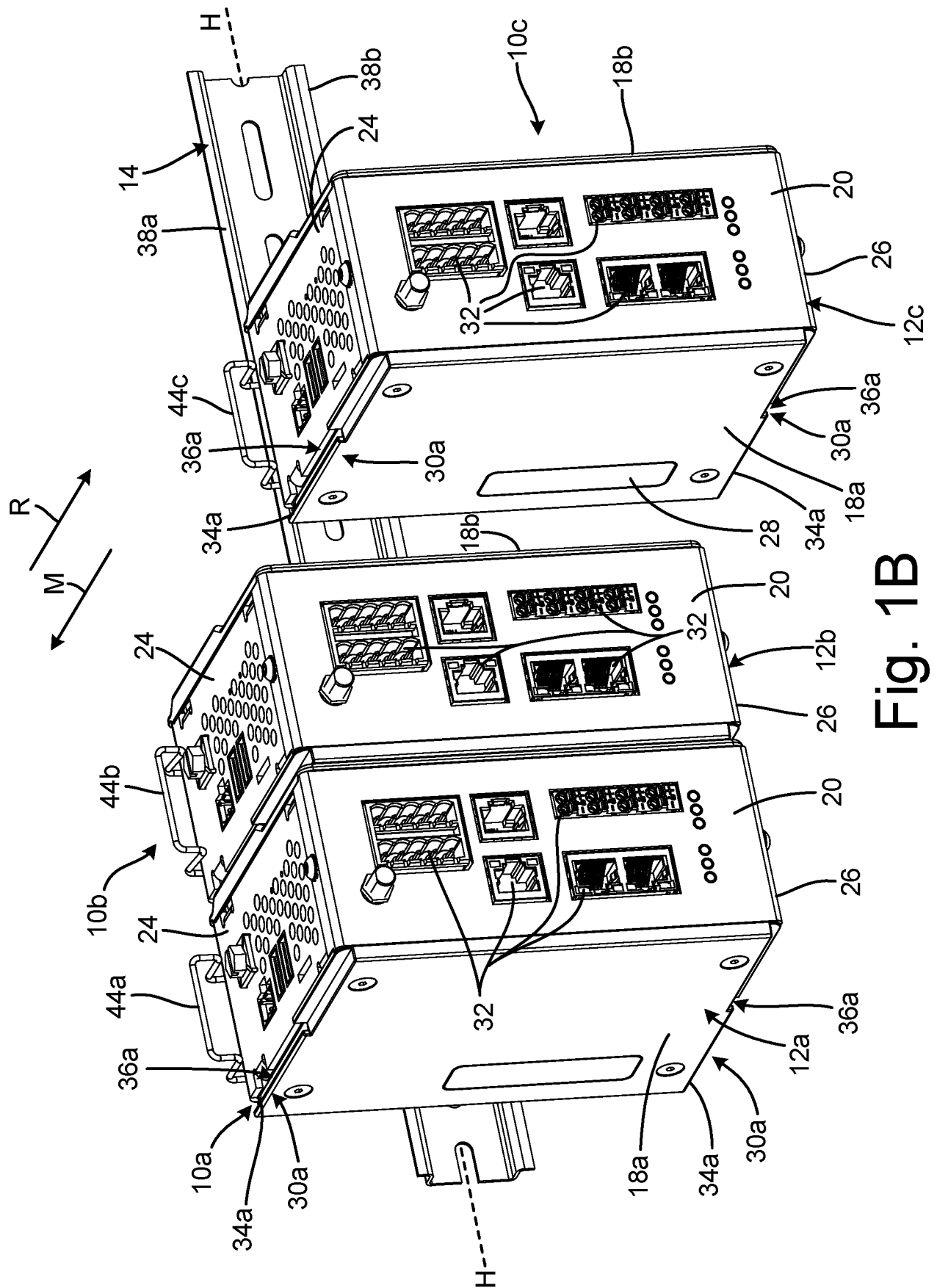


Fig. 1B

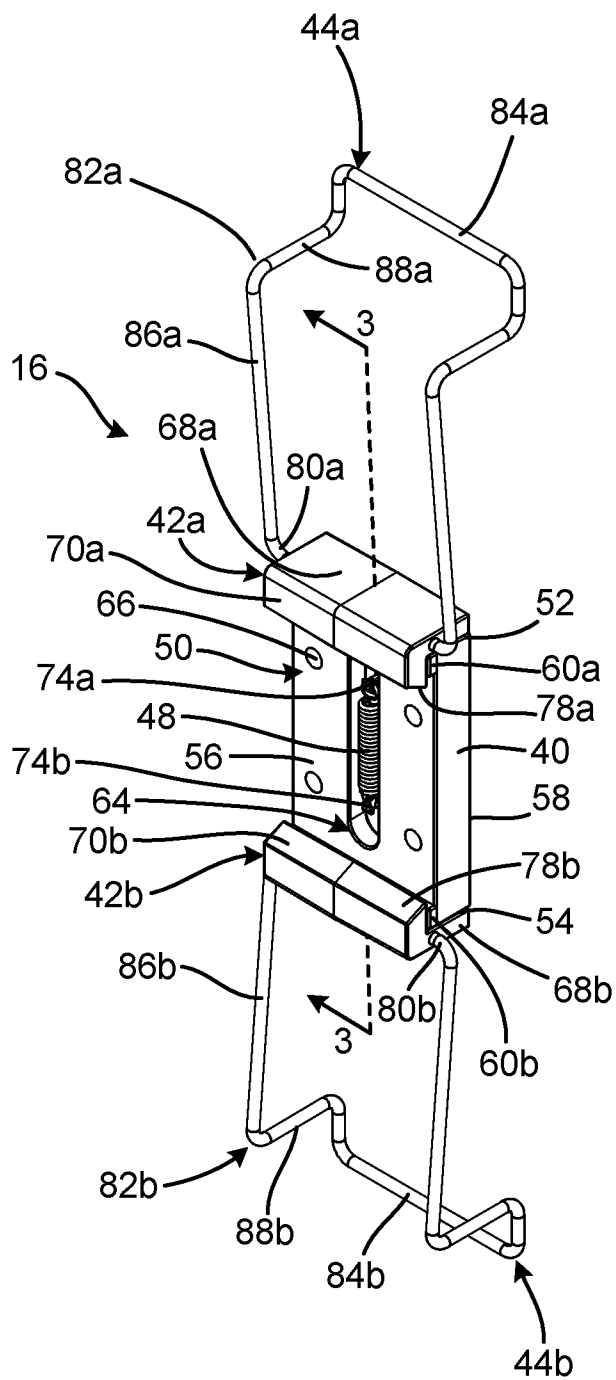


Fig. 2A

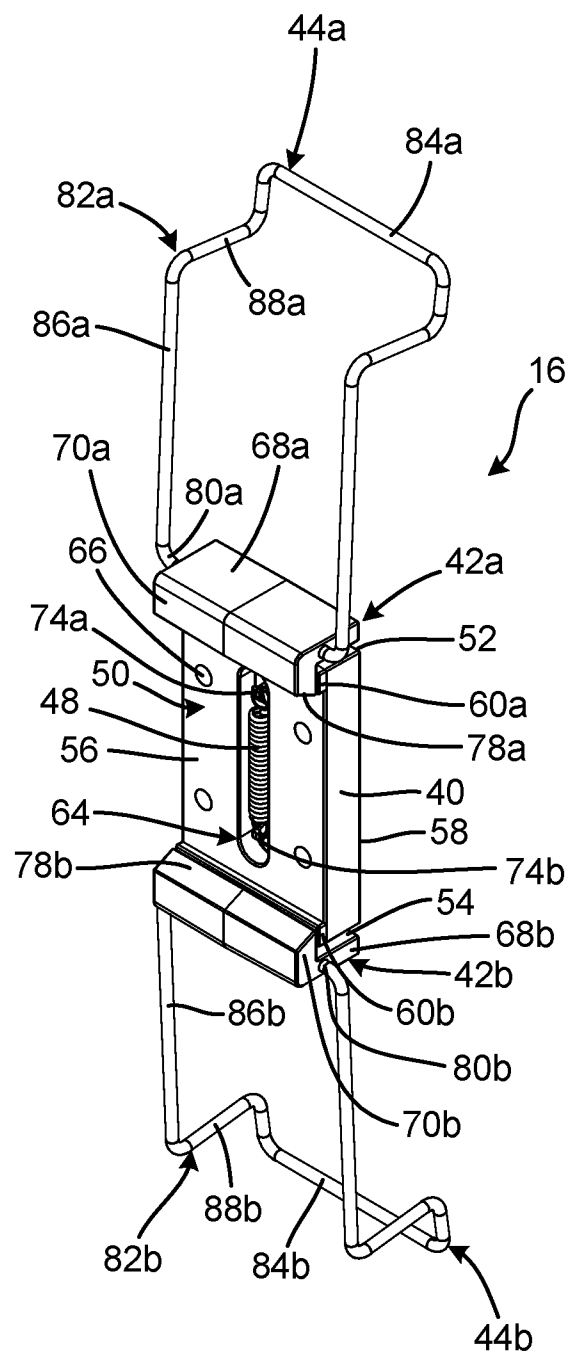


Fig. 2B

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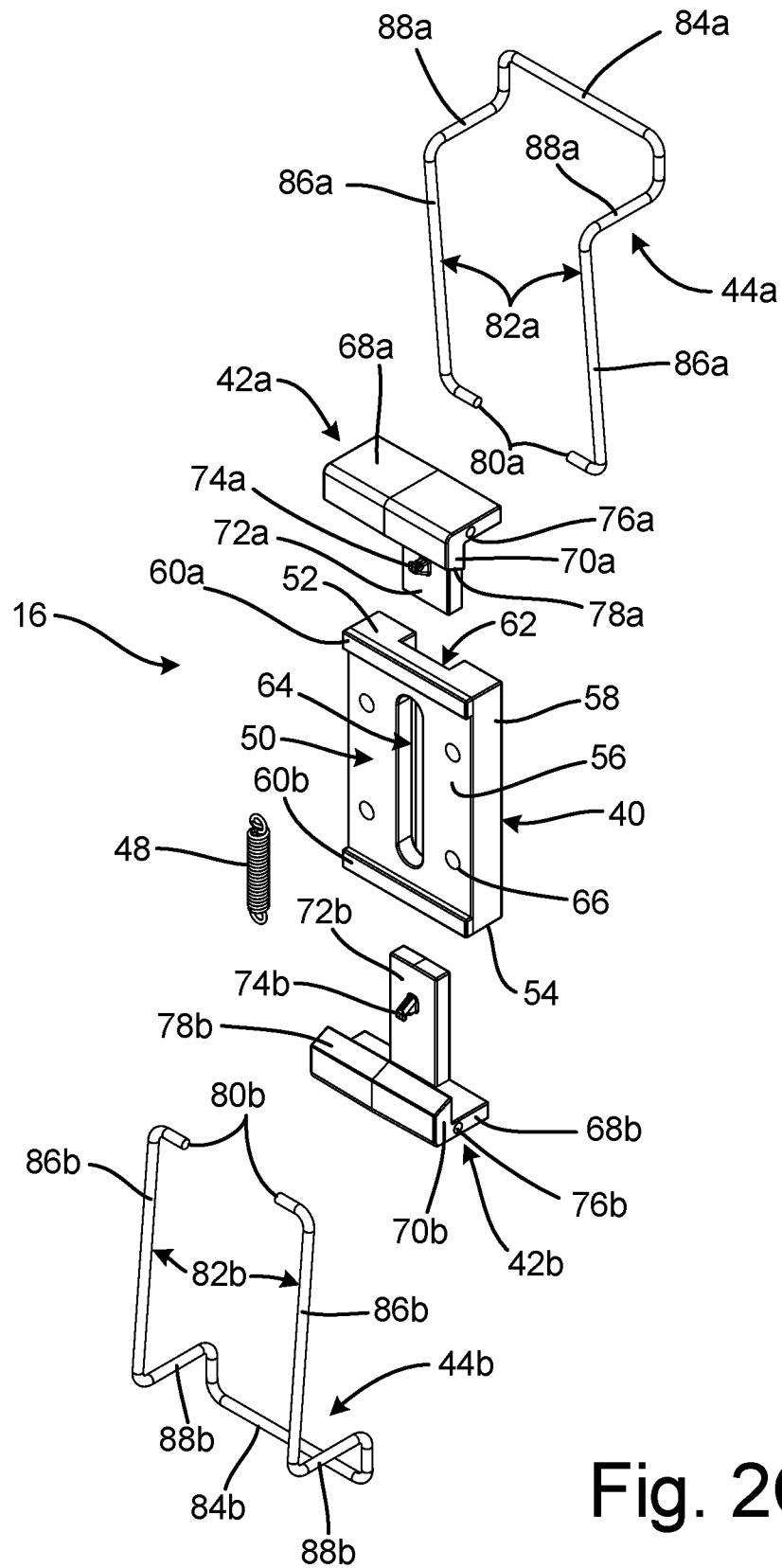


Fig. 2C

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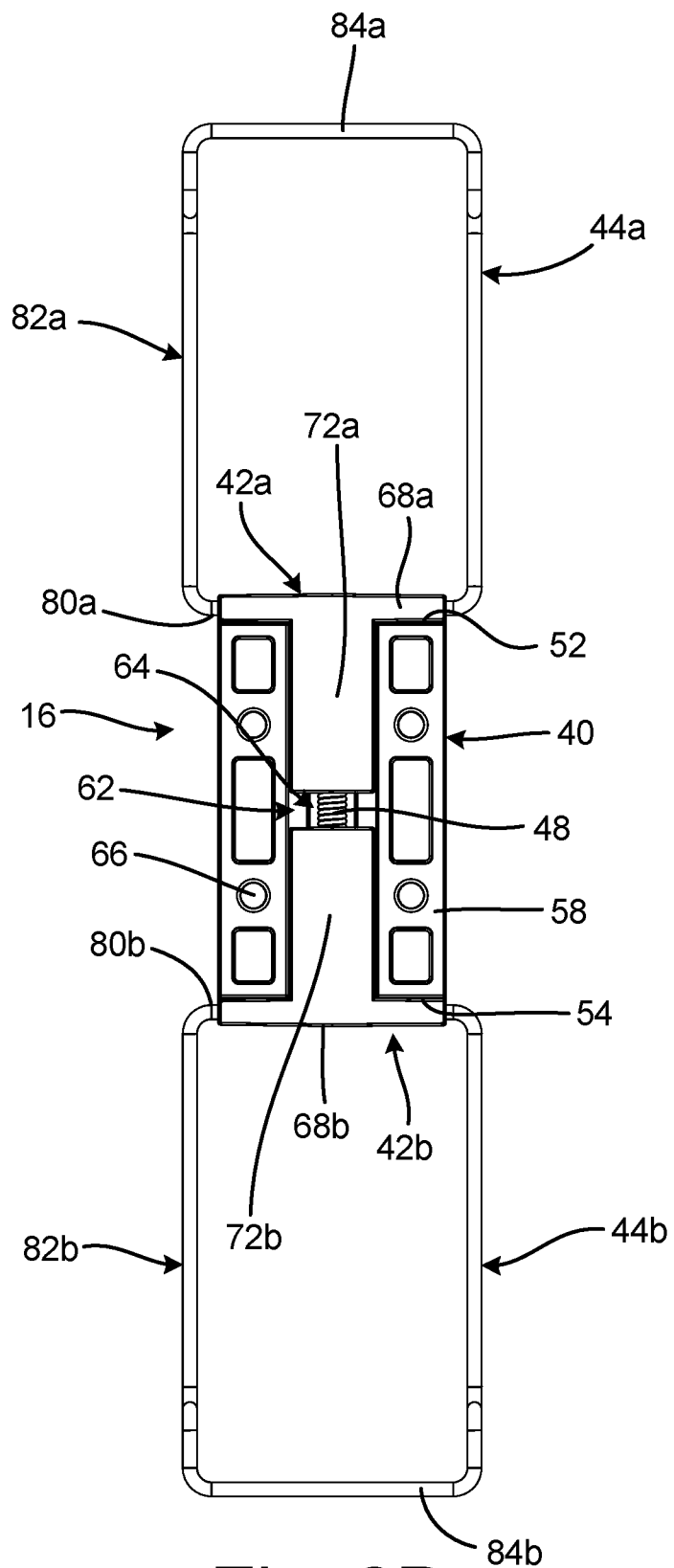


Fig. 2D

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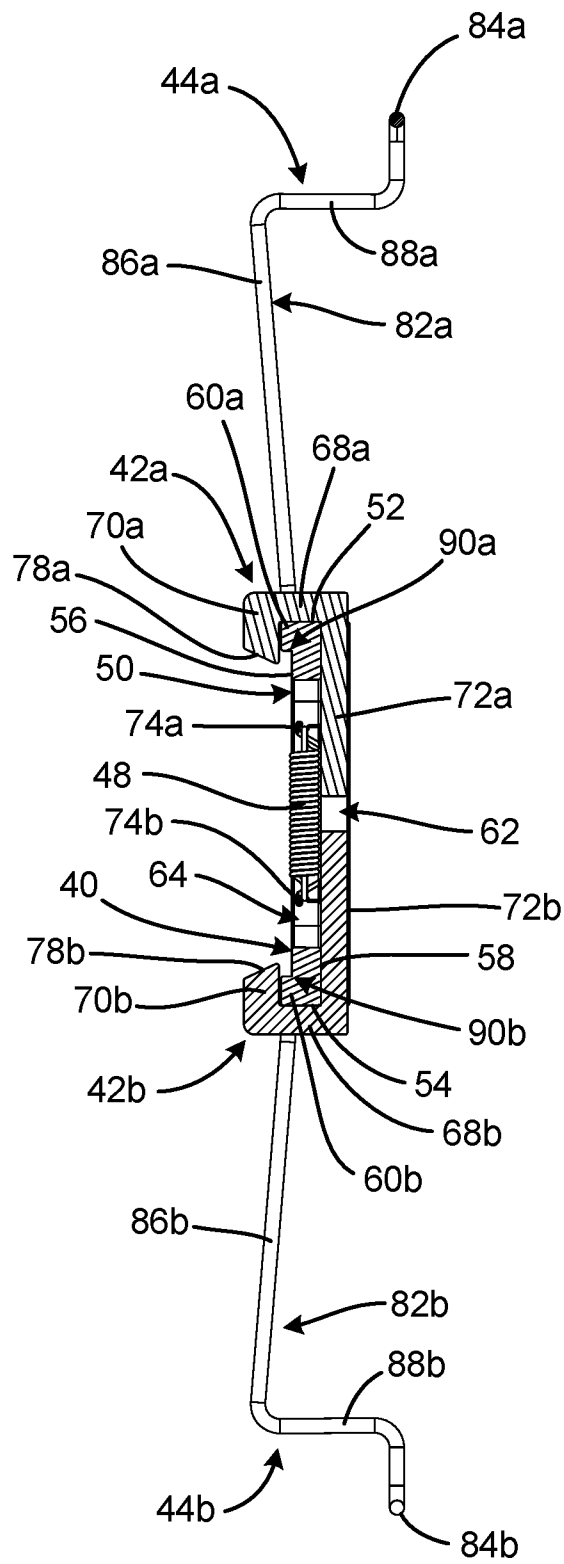


Fig. 3

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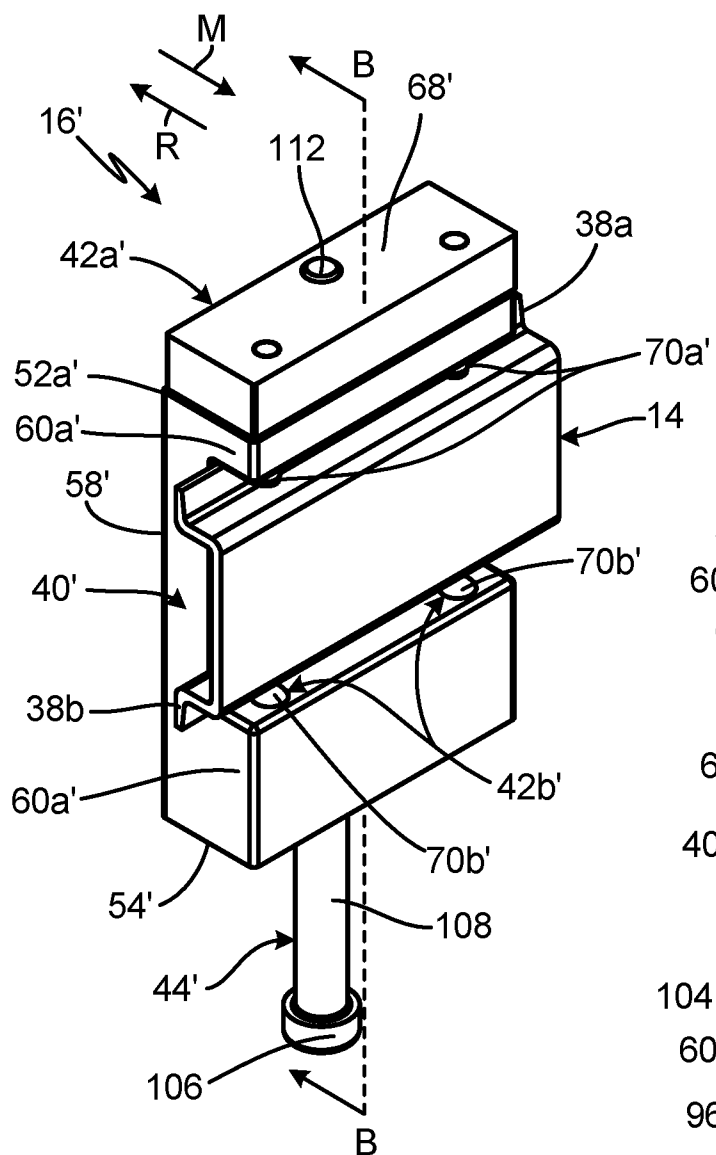


Fig. 4A

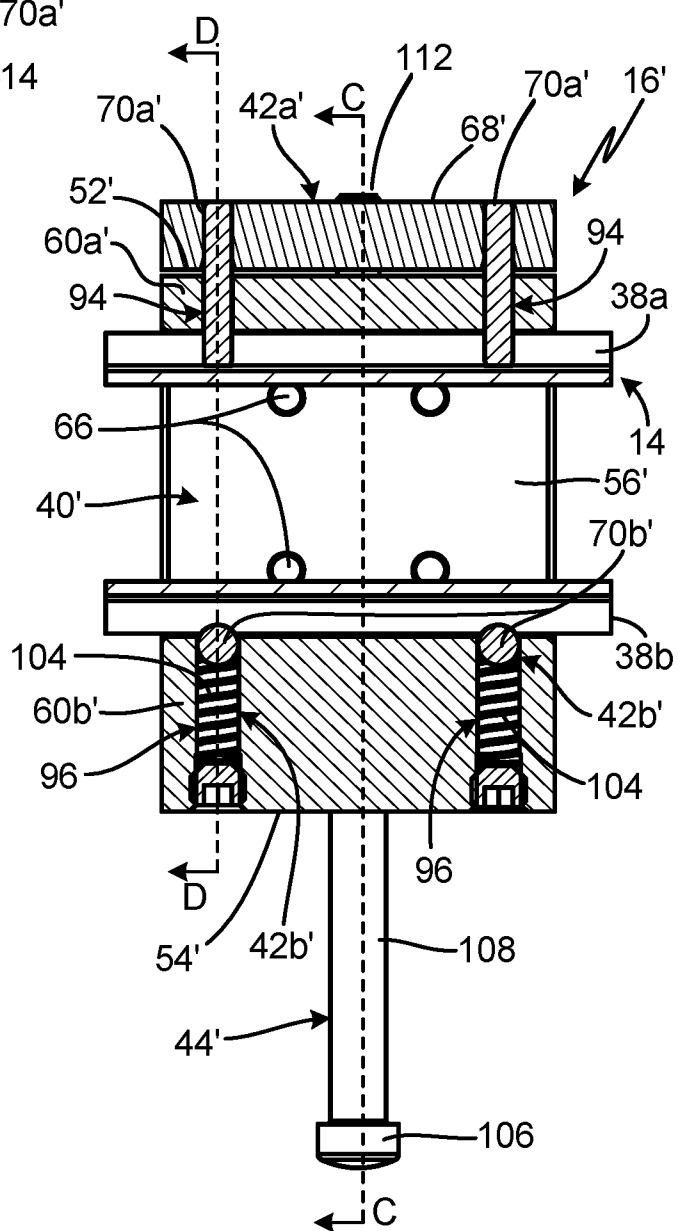


Fig. 4B

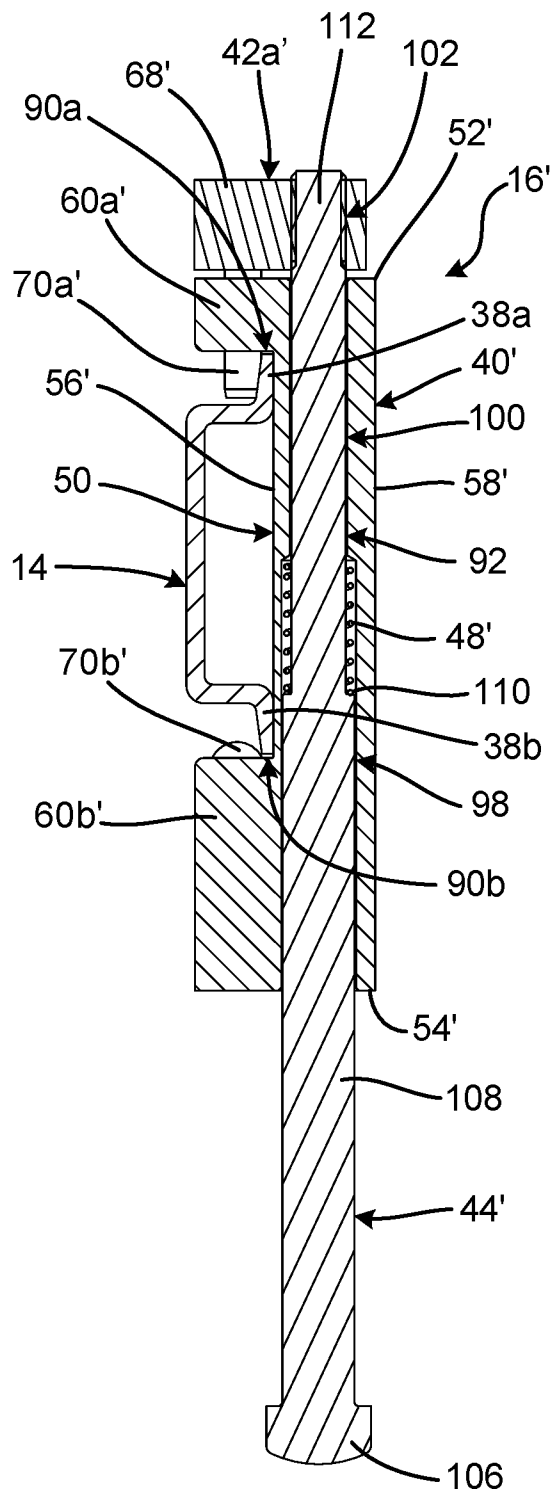


Fig. 4C

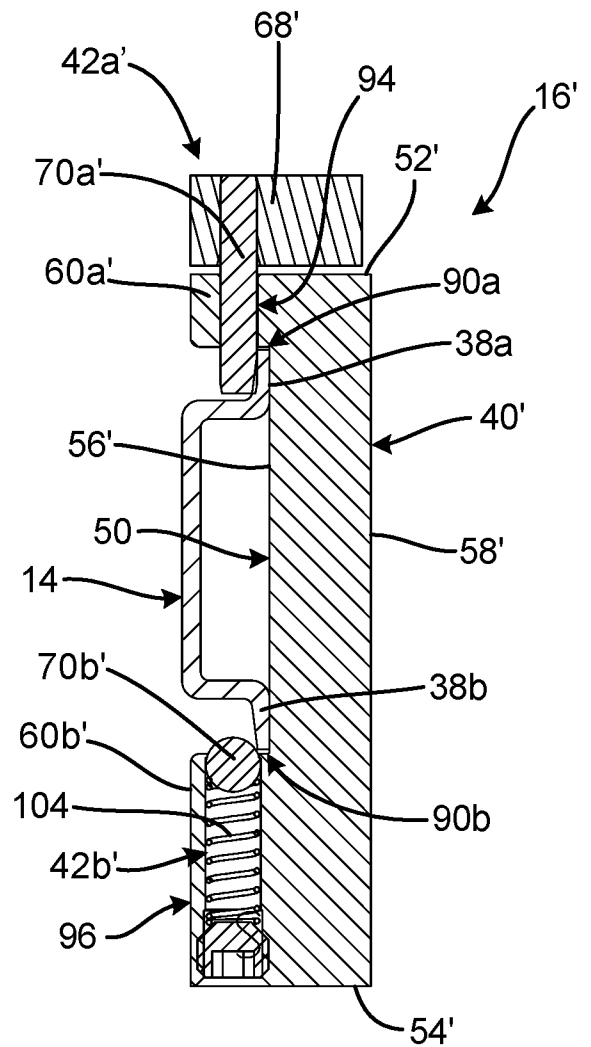


Fig. 4D

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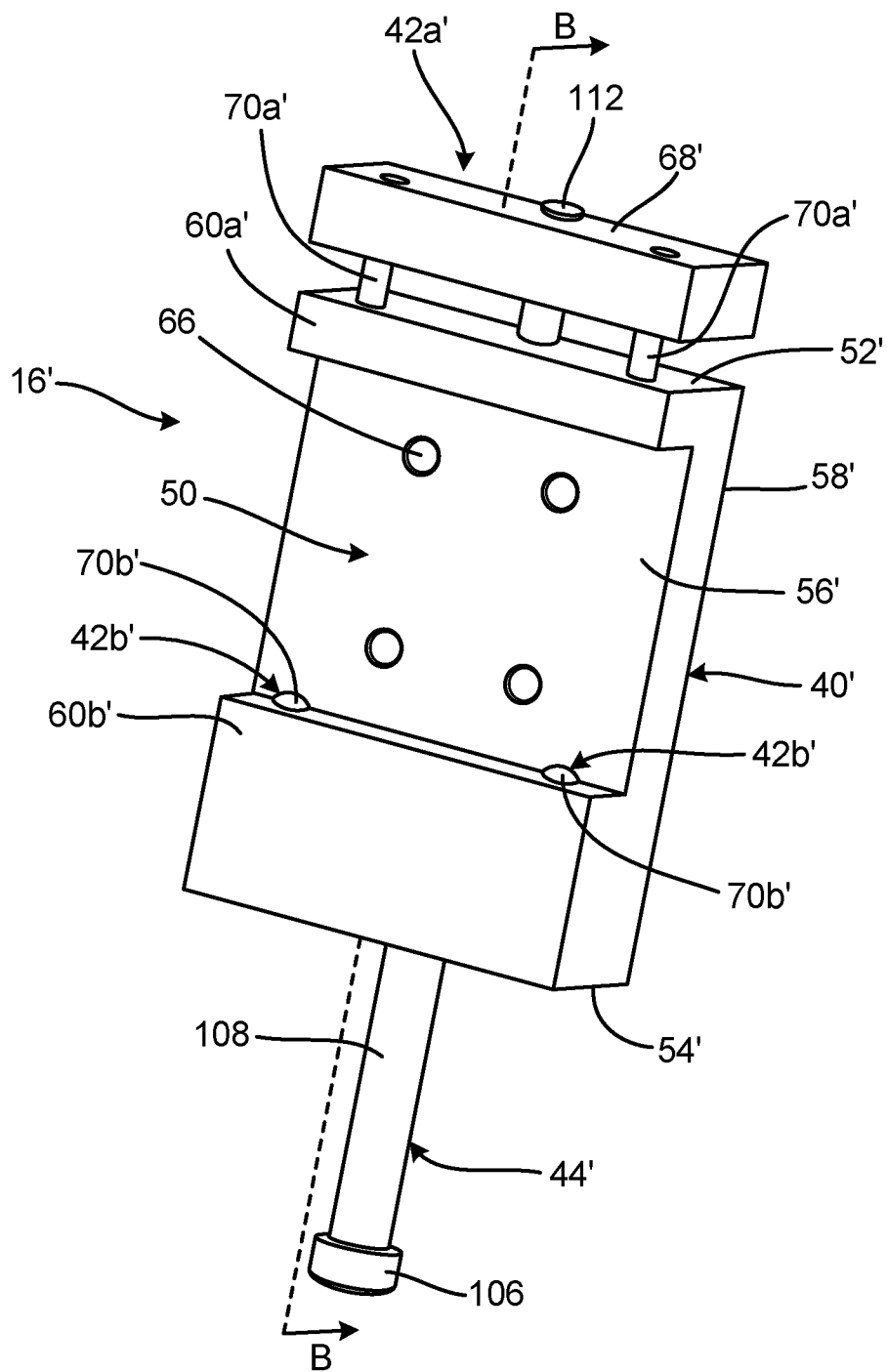


Fig. 5A

10/11

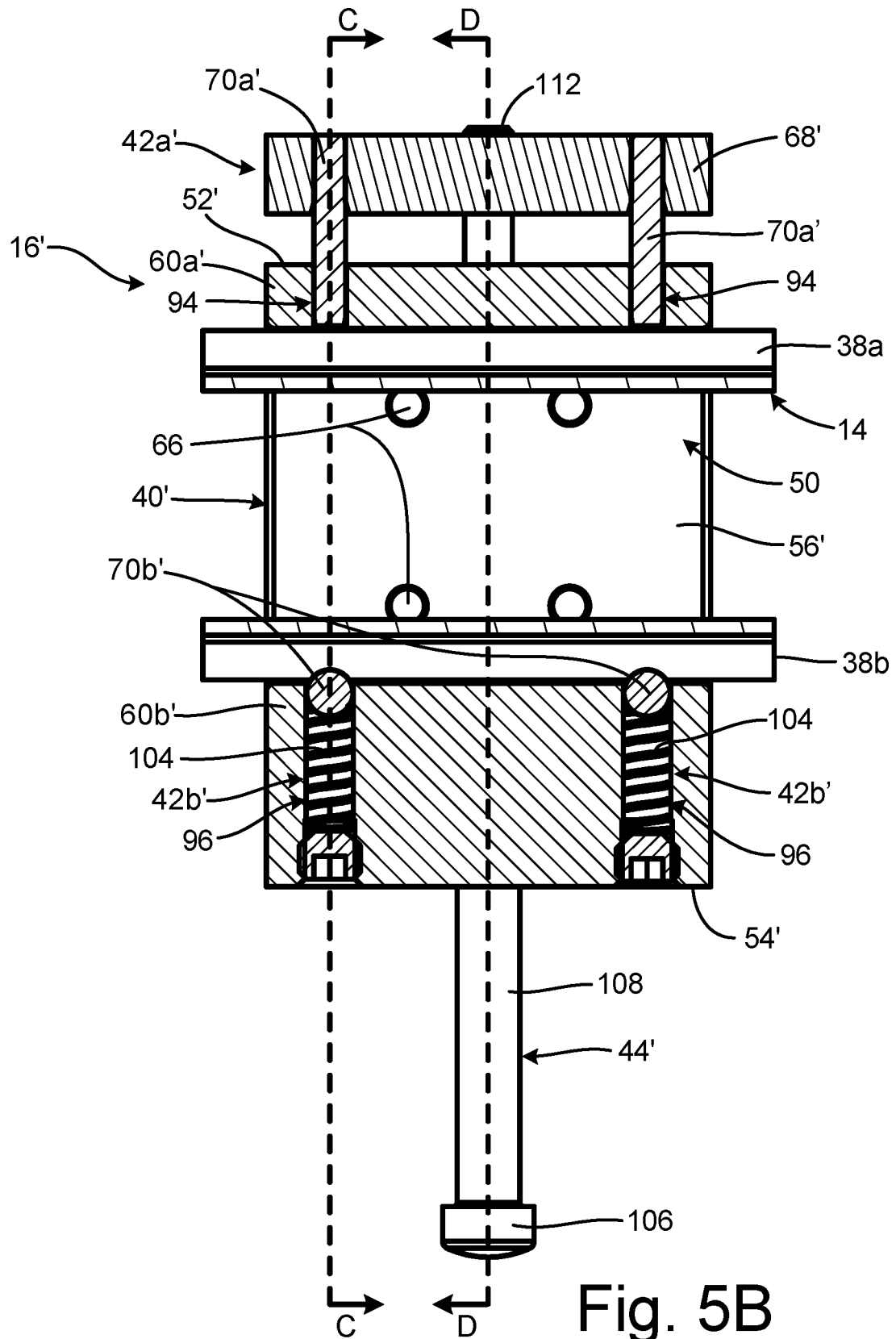


Fig. 5B

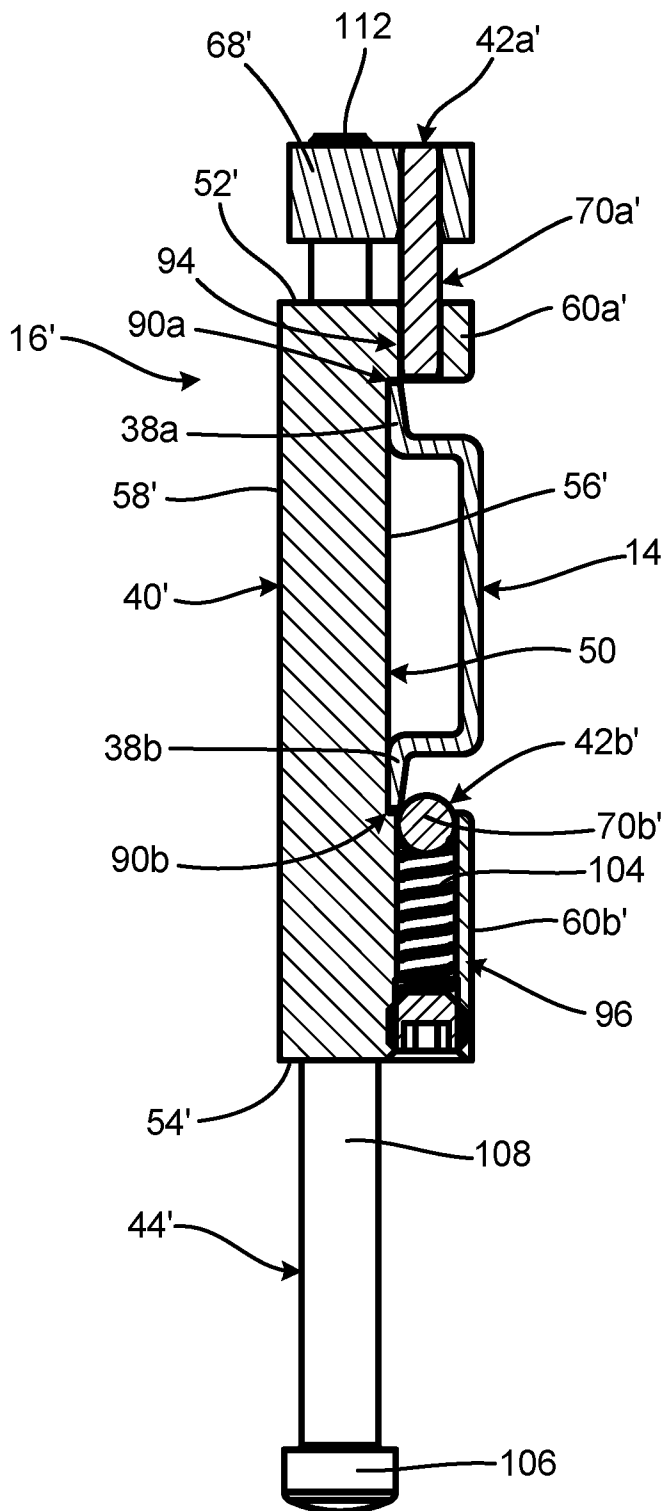


Fig. 5C

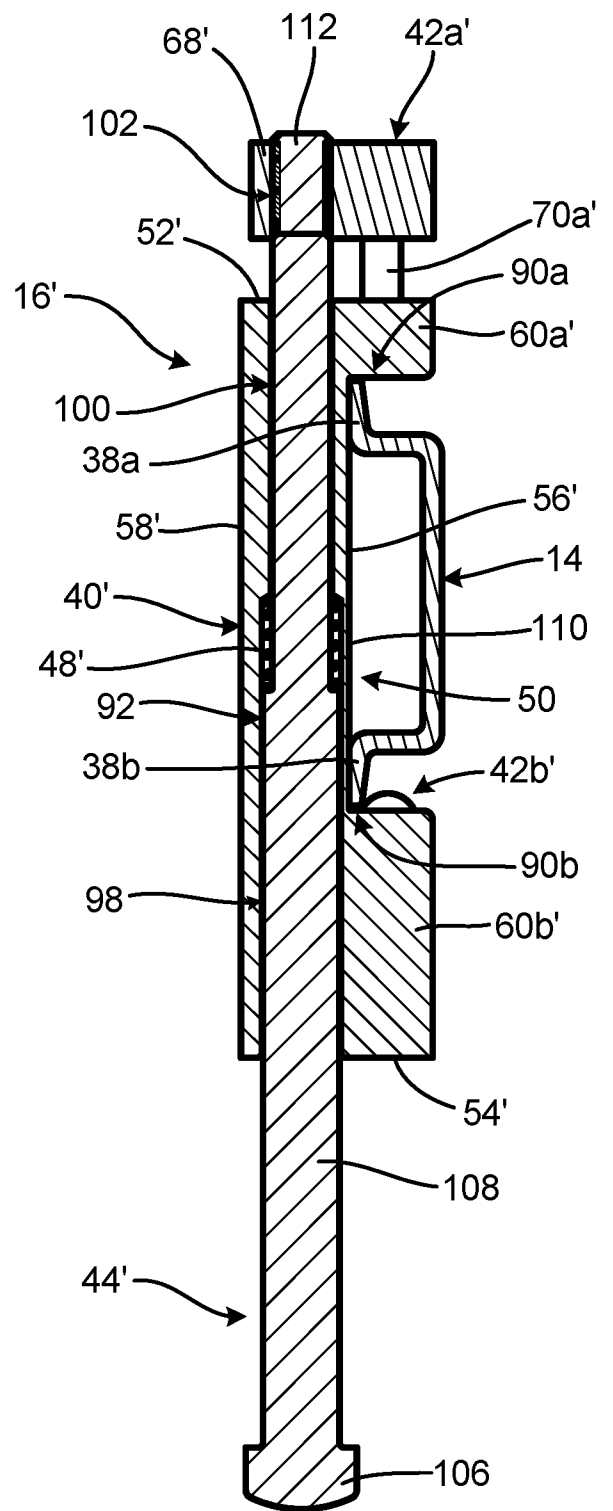


Fig. 5D

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2020/041932

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02B1/052 H05K7/14
ADD.

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)
H02B H05K H01R

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	US 2008/108248 A1 (LIM CHOO-SOO [TH] ET AL) 8 May 2008 (2008-05-08) abstract paragraph [0001] - paragraph [0060] figures 1-12	1-15,20 19 16-18
X Y	----- DE 10 2013 103544 A1 (BLOCK TRANSFORMATOREN ELEKTRONIK GMBH [DE]) 9 October 2014 (2014-10-09) abstract paragraph [0001] - paragraph [0050] paragraph [0054] - paragraph [0059] figures 1-6 ----- -/-	1-3,5,6, 20 19



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

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"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

28 September 2020

Date of mailing of the international search report

08/10/2020

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Authorized officer

Ruiz Ferrer, M

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2020/041932

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 10 2011 010828 A1 (BLOCK TRANSFORMATOREN ELEKTRONIK GMBH [DE]) 2 August 2012 (2012-08-02)	1-4,6-9, 14,15,20
Y	abstract	19
A	paragraph [0001] - paragraph [0063] figures 1-14	16-18

X	US 2010/203774 A1 (LANNING SCOTT RAYMOND [US] ET AL) 12 August 2010 (2010-08-12)	1-3,6,20
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	paragraph [0001] - paragraph [0025] figures 1-5	

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