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(54) **MULTIPOLE LINEAL SWITCH**

(57) The invention refers to a multi-pole electric switch device operated by a rectilinearly-movable actuator (5) for alternatively opening and closing the electric connection of the poles of the switch. Each pole (2, 3 or 4) of the switch is formed by a movable contact (2b, 3b or 4b) and two fixed contacts (2a, 2c or 3a, 3c or 4a,4c), wherein the movable contacts are formed as a single-plate contacts having upper and lower surfaces, such as in the closed position of the switch, only the upper or the lower surface of each of the movable single-plate contacts, is contacted by its associated fixed contacts of the first and the second group. The relative position between the movable contact and the fixed contacts of a pole of the switch, alternate from one pole to the adjacent ones. The switch is cheaper and easier to manufacture, and at the same time is capable of more efficiently quenching electric arcs originated during transient current interruption and closing operations.

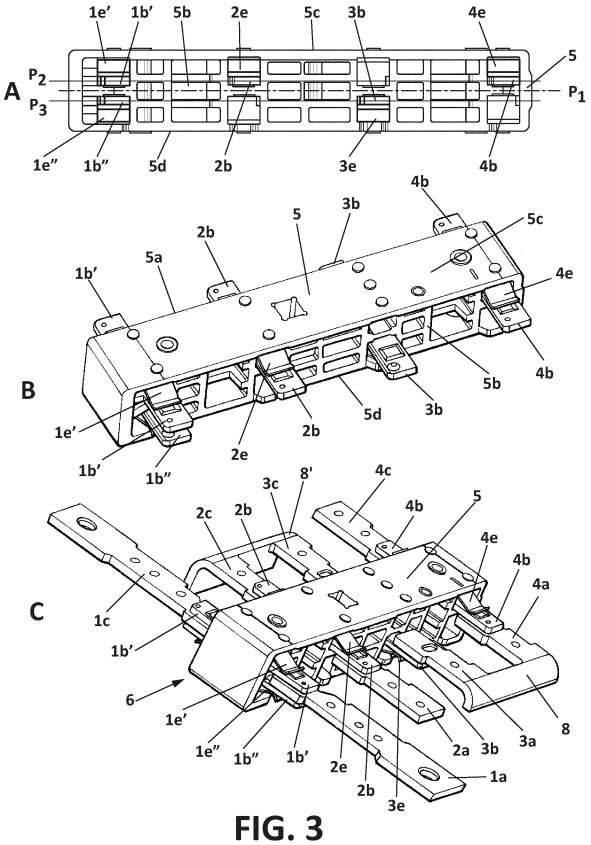

FIG. 3

EP 3 073 501 A1

Description

Object of the invention

[0001] The present invention refers in general to electric switches and/or circuit breaker devices, particularly adapted for quenching the electric arc generated at the contacts of a switch during opening and closing operations.

[0002] More particularly, the invention refers to a multipole electric switch device operated by a rectilinearly-movable actuator, for alternatively opening and closing the electric connection of the poles of the switch.

[0003] An object of the invention is to provide a multiple-pole lineal switch which is cheaper and easier to manufacture compared with prior art devices, and which at the same time is capable of more efficiently quenching or extinguishing electric arcs originated during transient current interruption and closing operations.

Background of the invention

[0004] Mechanical switches are devices used to connect and disconnect a load from an electric power source, and are based on applying an external force which moves several moving contacts with respect to other fixed contacts, such that when the circuit is to be closed, the moving contacts come into contact with the fixed contacts, forming the connection between load and a power source thereby allowing current circulation.

[0005] The opposite process corresponds to the movement of the moving contacts with respect to the fixed contacts, such that these moving contacts move away from the fixed contacts, causing the circuit to open and therefore interrupting current circulation.

[0006] The European patent application EP-2.667.394 A1 is an example of multi-pole lineal switch. This type of switches is represented in the attached figures 1A,B for the case of four pole switches, and comprises a first group of fixed contacts (1a,2a,3a,4a), a second group of fixed contacts (1c,2c,3c,4c), and a group of moving contacts (1b,2b,3b,4b) capable of moving simultaneously between an electrical open position and an electrical closure position of the switch, such as for each pole of the switch, a moving contact electrically connects a fixed contact of the first group with a fixed contact of the second group. Therefore, each pole of the switch is formed by a movable contact and its associated fixed contacts, for example a first pole is defined by contacts (1 a, 1 b, 1 c), a second pole is defined by contacts (2a,2b,2c) and so on. Each pole may be used to open and close an individual electric line of an installation. Alternatively, as shown in figure 1, some poles are permanently connected in series in order to break the circulation of current in several cutting points, in order to simply thereby extinction of the electric arc.

[0007] The group of movable contacts are assembled with an actuator (5), which is rectilinearly-movable alternatively between an open position and a closed position of the switch. As shown in figures 1 and 2, conventionally these movable contacts, are double-plate contacts, such as each movable contact (1 b,2b,3b,4b) is formed by two superimposed plates (1b',1b"),(2b',2b"),(3b',3b"),(4b',4b") respectively, such as a gap is defined between both plates, in which a contacting portion of the associated fixed contacts is tightly inserted in the closed position contacting on two surfaces respectively with the two plates, as shown in more detail in drawing 2C.

[0008] This double-plate configuration has been traditionally used for decades. The reason for this is that with two superimposed plates the contacts withstand better the high short-circuit currents. Since an electric current generates an electromagnetic field, the movable and fixed contacts are biased apart from each other by the generated electromagnetic field. To compensate this repelling force, elastic elements are usually used forcing movable and fixed contacts together, otherwise sparks would appear and the contacting surfaces would be deteriorated.

[0009] Due to these superimposed plates, the current is equally distributed by each one of them in the same direction, in such a way that due to the generated electromagnetic fields, the superimposed plates are attracted to each other, such as this attraction force is added to the force of the electric elements, to the extent that the movable contacts are capable of resisting high short-circuit forces.

[0010] Electric arcs or voltaic arcs are formed during transient operations, at the contacting areas between movable and fixed contacts. Electric arcs are known to cause many problems because the heat generated during an electric arc is highly destructive. Some of these problems are: deterioration of the switch material, breakdowns and/or complete or partial destruction of electrical installations, including damage to people caused by burns or other types of injuries.

[0011] The problems in quenching electric arcs are particularly pronounced in direct current interruption because, unlike the alternating current, there is no zero-crossing, so that electric arcs must be eliminated as quickly as possible by means of deionizing the medium and increasing dielectric strength.

[0012] Several techniques are known today for extinguishing electric arcs formed when the contacts in a breaker switch or disconnect switch open and close. The common objective shared by all these techniques is for the energy dissipated in the heat of the electric arc to be as little as possible, with the ultimate goal of being nil. To that end, time control is the critical variable that is acted on so that the rate of extinction of the electric arc is as rapid as possible.

[0013] Several techniques are known to meet said objective, among which the following may be pointed out:

a) Increase in the gap between the fixed and moving

contacts of the electric switch, which involves a larger volume of air between them and therefore a larger size of the switch.

- Increase in speed of tripping devices.
- Radial interruption.
- Connecting simultaneous contacts in series.

b) Increase in length or "elongation" of the electric arc for one and the same instant in time.

- Spark quenching chambers.
- Magnetic and pneumatic blowout.

[0014] However, in order to implement these known devices for quenching arcs, it is generally necessary to increase the weight and/or the volume of the switches, which in turn increases the production costs, and need specific design of these switches to achieve that purpose.

Summary of the invention

[0015] The present invention is defined in the attached independent claims and it overcomes the above-mentioned drawbacks of the prior art, by providing a multi-pole lineal switch, in which the movable contacts of the same are advantageously configured and positioned, such as less material in needed for the implementation of these movable contacts, such as in addition to the reduction of the material used, the weight of the movable actuator is reduced, which in turn implies a faster movement of the actuator and an enhanced electric arc extinction capacity.

[0016] More particularly, an aspect of the invention refers to a multi-pole lineal switch comprising a first group of at least two and preferably at least three fixed contacts, and a second group of at least three fixed contacts. A rectilinearly-movable actuator made of an insulating material, is provided in the switch to operate the same by alternatively between an open position (current circulation cut-off) and a closed position (current circulation enabled) of the switch.

[0017] A group of at least two and preferably at least three movable contacts is assembled with the actuator for electrically connecting in the closed position of the switch, a fixed contact of the first group and a fixed contact of the second group, and for disconnecting those fixed contacts in the open position. Therefore, the switch of the invention has at least three poles, wherein each pole is formed by a movable contact and its two associated fixed contacts, one of the first group and another form the second group. Each of said fixed contacts of the first and second groups, have preferably only one contacting surface for contacting with their associated movable contact.

[0018] The switch of the invention is characterized by the configuration of at least three of its movable contacts, and by the relative arrangement between the movable contacts and fixed contacts. First, with respect to the configuration, each of said three movable contacts is formed by (or consist of) only one metallic plate, so that these movable contacts may be referred as single-plate contacts, which preferably are flat and have upper and lower surfaces.

[0019] Therefore, in the closed position of the switch, only the upper surface or the lower surface of each of these movable single-plate contacts, is contacted by a contacting part of its associated fixed contacts (of the same pole) of the first and the second group, whereas the other non-contacted surface of the movable single-plate contact, is open which means that it is surrounded by air or that it is in contact only with air.

[0020] Therefore, unlike prior-art switches of this lineal type, wherein these movable contacts have been always formed by a pair of two superimposed plates (as the one shown in figure 1, and for example plates (3b',3b") in drawing 2C), according to the present invention, three or more of the movable contacts are formed by only one plate.

[0021] A technical effects associated to this feature, are that less material is used for manufacturing the switch, the overall weight of the actuator is reduced, and the switching capabilities are enhanced. A weight reduction of the actuator up to 25% to 40% can be achieved with the invention, depending of the type of switch.

[0022] Some advantages of the invention, are that manufacturing costs and production times are thereby reduced. Additionally, environmental impacts are significantly reduced due to the reduction in the use of row materials, as well as the pollution caused during transportation of the switches is also reduced.

[0023] The actuator is conventionally moved by an external actuation device based on a spring or similar elastic element, wherein the energy of a compressed spring is used to move the actuator upon releasing the spring. The weight reduction of the actuator involves an additional advantage, since the actuator is now lighter, the actuation device with the same energy, has to move less mass or weight, which result in that the actuator is accelerated faster, and the electric arcs generated at the cutting areas, are extinguished earlier. To this effect, also contribute the fact that due to the single-plate movable contact, the friction between the movable and fixed contacts is reduced, and the actuator can be accelerated even faster.

[0024] An additional feature of the invention refers to the relative arrangement between these three movable single-plate contacts and the fixed contacts. According to the invention, the relative position between the movable single-plate contact and the fixed contacts of a pole of the switch, alternate from one pole to the adjacent or consecutive ones.

[0025] The movable single-plate contacts are positioned either above or below its associated fixed contact of the same pole, and the at least three movable single-plate contacts and the fixed contacts of the first and sec-

ond groups are positioned in the switch, such as the (upper or lower) surface of a movable single-plate contact which is contacted by associated fixed contacts, alternate from one movable single-plate contacts to the adjacent or consecutive ones. For example, if in one pole the movable single-plate contact is placed over its associated fixed contacts, in the adjacent or adjacent poles formed by movable single-plate contacts, the movable single-plate contact is placed under the respective fixed contacts

[0026] The effect associated to this feature, is that the actuator is mechanically balanced.

Brief description of the drawings

[0027] Preferred embodiments of the invention, are henceforth described with reference to the accompanying drawings, wherein:

Figure 1.- shows a lineal switch of the prior art, wherein drawing (A) is a top plan view, and drawing (B) is a perspective view.

Figure 2.- shows a side view of an schematic representation of a lineal switch of the prior art with double-plate movable contacts, wherein only fixed and movable contacts are represented for the sake of clarity of the illustration, wherein drawing (a) shows the switch in its contacted or closed position, and drawing (b) shows the switch in its cut-off or open position. Drawing (c) is a cross-sectional view taken along line A-A in drawing (A).

Figure 3.- shows a preferred embodiment of a lineal switch according to the invention in its closed position, wherein drawing (a) is a side elevational view of the actuator; and drawings (b,c) are perspective views.

Figure 4.- shows a similar representation than figure 2, but corresponding to a preferred embodiment of a lineal switch according to the present invention.

Figure 5.- shows the same embodiment of figure 4 in open position, wherein drawing (A) is a top plan view and drawing (b) is a perspective view.

Figure 6.- shows a similar representation than figure 3 but corresponding to another preferred embodiment of the invention.

Figure 7.- shows the same embodiment than figure 6 but in its open position, wherein drawing (A) is a top plan view and drawing (B) is a perspective view.

Figure 8.- shows another preferred embodiment of the invention in perspective view.

Preferred embodiment of the invention

[0028] Figures 3 and 5 show a preferred embodiment of a multi-pole switch (6) according to the invention, in this case a four-pole switch, comprising an actuator (5) made of an insulating material, adapted and arranged in the switch to move in a rectilineal phasion along axis (X) and alternatively between an open position (figure 5) and a closed position (figure 3) of the switch.

[0029] The actuator (5) has generally rectangular prismatic configuration having four lateral sides, two lateral sides (5a,5b) and top and bottom sides (5c,5d). A group of three moving single-plate contacts (2b,3b,4b) are assembled with the actuator (5) and are longitudinally arranged in the same, wherein each of these movable single-plate contacts (2b,3b,4b) consist of a substantially flat metal plate having upper and lower surfaces. The two ends of these moving single-plate contacts (2b,3b,4b) protrudes respectively through the lateral sides (5a,5b) of the actuator (5).

[0030] The switch (6) further comprises a first group of fixed contacts (2a,3a,4a) arranged at one lateral side (5b) of the actuator, and a second group fixed contacts (2c,3c,4c) arranged at the opposite lateral side (5a), such as the actuator (5) is placed between the first and the second groups of fixed contacts. The fixed contacts are fitted at fixed position of a housing (7) of the switch (shown in figure 5).

[0031] The movable single-plate contacts and the fixed contacts are arranged in the switch, such as each moving single-plate contact electrically connects in the closed position of the switch, a fixed contact of the first group and a fixed contact of the second group. Therefore, each pole of the switch is formed by a movable contact and its associated fixed contacts, for example a first pole is defined by contacts (1a,1b,1c), a second pole is defined by contacts (2a,2b,2c), a third pole is defined by contacts (3a,3b,3c) and so on.

[0032] Since the fixed contacts of the first and second groups have only one contacting surface for contacting with their associated movable contact, in the closed position of the switch, only the upper or the lower surface of each of the movable single-plate contacts, is contacted by its associated fixed contacts of the first and the second group. This feature is more clearly illustrated in figure 4, for example in the case of drawing 4C, only a part of the lower surface of the movable single-plate contact (3b) is contacted by the fixed contacts (3a,3c) of the same pole, whereas the upper surface of the same is not contacted, thus, it could be said that that part of the upper surface is completely open to the air.

[0033] The same arrangement is repeated for the other poles, but with the particularity that the surface (upper or lower) of a movable single-plate contact which is contacted by its associated fixed contacts (of the same pole), alternate from one pole to the adjacent ones.

[0034] Therefore, relative position between the movable single-plate contact and the fixed contacts of a pole

of the switch, varies from one pole to the adjacent or consecutive ones. For example, if in one pole the movable single-plate contact is placed over its associated fixed contacts, in the adjacent or adjacent poles formed by movable single-plate contacts, the movable single-plate contact is placed under the respective fixed contacts.

[0035] It should be noted here, that the switch (6) of the invention may also have one or more conventional movable double-plates contacts, arranged in any position of the actuator (5). This is the case of the embodiment of figures 3 and 5, wherein the movable contact (1b) is formed by two superimposed plates (1b',1b"). The above-described alternated arrangement according to the invention, refers only to the poles with movable single-plate contacts.

[0036] In the embodiment of figure 3 and 5, in the intermediate pole formed by contacts (3a,3b,3c) the movable contact (3b) is arranged under the fixed contacts (3a,3c), whereas in the adjacent poles to this one, that is, poles (2a,2b,2c) and (4a,4b,4c), the respective movable contact (2b,4b) are placed over the respective fixed contacts (2a,2c) and (4a,4c). It would be clear that in other embodiments of the invention, other configurations are possible as long as the relative position between movable and fixed contacts alternate from pole to any adjacent pole with single-plate movable contact. For example, in the case of figure 4 the movable contact (3b) of the intermediate pole is above the adjacent movable contacts (2b,4b). In the embodiment of figures 6 and 7, the four poles of the switch have movable single-plate contacts with the alternated layout of contacts.

[0037] Each one of the fixed contacts of the first and second groups have a substantially flat contacting portion in the form of a plate, such as a contacting surface is defined therein for contacting with the associated movable single-plate contact. Preferably, these contacting portions are substantially coplanar, that is, they are all laying within the same first plane (P1) (see drawing 3A). Some movable single-plate contacts (2b,4b) are also coplanar and are laying on a second plane (P2) above the first plane (P1), and some other movable single-plate contacts (1 b",3b) are also coplanar and are laying on a third plane (P3) below said first plane (P1). The separation gap between said second and third planes (P2,P3) is substantially similar to the thickness of the contacting portion of the fixed contacts, (see drawing 4A).

[0038] It can be noted therefore, that the alternated layout of contacts in this embodiments have been achieved by placing the fixed contacts on the same plane, and alternating the position of the movable single-plate contacts, up and down as to form a kind of waving layout as it can be seen in drawings 3A, 4A, 6A. However, in other embodiments, the same effect can be achieved for example by placing the movable single-plate contacts on the same plane, and alternating up and down the position of the fixed contacts.

[0039] Some poles of the switch can be connected in series, and for that the switch may include one or more metallic bridges (8,8'), formed as a one-piece (unitary body) "U"-shaped bridge, such as each of the two arms forms a fixed contact. In the embodiments of figures 3,5,6 and 7, a first U-shaped bridge (8) have arms defining fixed contacts (3a,4a), and a second U-shaped bridge (8') have arms defining fixed contacts (2c,43), such as three poles of the switch with single-plate movable contacts are inter-connected in series through a U-shaped bridge, and a fourth pole (1 a,2a,3a) is not connected to the other ones.

[0040] Additionally, the switch includes an elastic element (2e,3e,4e) for each movable single-plate contact, wherein the elastic elements are assembled with the actuator and coupled with their respective movable single-plate contact, and are arranged to urging the movable single-plate contact towards the associated fixed contacts in the closed position of the switch, in order to enhance and maintain suitable contact between the two elements. In the embodiment of figure 3, the conventional two-plates movable contact (1b',1b") has respective elastic element (1e',1e").

[0041] Figure 8 shows another preferred embodiment of the invention, wherein the poles (2a,2b,2c), (3a,3b,3c), (4a,4b,4c) are interconnected in series, and in turn this group of poles is connected in parallel with the fourth or additional pole (1a,1b,1c). This can be done for example by connecting in the embodiment of figure 5 or 7, a fixed contact (4c) with fixed contact (1c) by means of a connection (9), and by connecting fixed contact (2a) with fixed contact (1a) of the pole (1a,1b,1c) by means of a second connection (9').

[0042] These connections (9,9') can be implemented in different ways, for example simply by means of a wire or plate of suitable size as the one shown in figure 8 connecting the fixed contact. In a preferred embodiment, each of these connections (9,9') consist of a single-piece metallic member (not shown), configured to have a first part to serve as a fixed contact (for example fixed contact (4c)), a second part configured to serve as another fixed contact (for example fixed contact (1c)) of the same group, and a third part connecting first and second parts.

[0043] Additionally, the switch is configured such as the path that the moving contact of the poles interconnected in series (2a,2b,2c), (3a,3b,3c), (4a,4b,4c) must travel until contacting with its respective fixed contacts is shorter than the path that the moving contacts of the pole (1 a, 1 b, 1 c), must travel until contacting with its respective fixed contacts, such that in the electrical switch closing operation, the poles (2a,2b,2c), (3a,3b,3c), (4a,4b,4c) closes before the fourth pole (1a,1b,1c).

[0044] With this arrangement, in a closing operation, the poles interconnected in series (2a,2b,2c), (3a,3b,3c), (4a,4b,4c) are connected in the transient state, which is advantageous for interrupting the electric arc by splitting it into several interruption points, as explained above. The fourth pole (1 a, 1 b, 1 c) less electrical resistance

than the group of poles interconnected in series, is connected in the permanent or idle period of the switch, short-circuiting the first mechanism, such that all or almost all of the current passes through this second circuit breaker mechanism during the permanent state of the switch.

Claims

1. Multi-pole lineal switch comprising:

a first group of at least two fixed contacts,
a second group of at least two fixed contacts,
a rectilinearly-movable actuator made of an insulating material, which is alternatively movable between an open position and a closed position of the switch,
a group of at least two movable contacts assembled with the actuator for electrically connecting in the closed position of the switch, a fixed contact of the first group and a fixed contact of the second group, such as a pole of the switch is formed by a movable contact and its associated fixed contacts,
wherein each of said fixed contacts of the first and second groups have a contacting surface for contacting with their associated movable contact,
characterized in that each of said two movable contacts is a single-plate contact formed by a metal plate having upper and lower surfaces, such as in the closed position of the switch, only the upper or the lower surface of each of the movable single-plate contacts, is contacted by its associated fixed contacts of the first and the second group,
and wherein said at least two movable single-plate contacts, and the at least two fixed contacts of the first and second groups, are arranged such as the surface of a movable single-plate contact which is contacted by its associated fixed contacts alternate from one movable single-plate contacts to adjacent ones.

2. Switch according to claim 1 wherein the first group of fixed contacts comprises at least three fixed contacts, and the second group of fixed contacts comprises at least three fixed contacts, and the group of movable contacts comprises at least three movable contacts.

3. Switch according to claim 1 or 2, wherein the movable single-plate contacts are positioned above or below its associated fixed contact of the same pole, and wherein the movable single-plate contacts and the fixed contacts of the first and second groups are positioned in the switch, such as the relative position between the movable single-plate contact and the fixed contacts of a pole of the switch, alternate from one pole to the two adjacent ones.

4. Switch according to any of the claims 1 to 3, wherein each one of the fixed contacts of the first and second groups are configured to have a substantially flat contacting portion (in the form of a plate) wherein said contacting surface is defined, and wherein these contacting portions are substantially coplanar.

5. Switch according to claim 4, wherein the separation gap between said second and third planes is substantially similar to the thickness of the contacting portion of the fixed contacts.

6. Switch according to any of the preceding claims, wherein the first group of fixed contacts is arranged at a first side of the actuator, and the second group of fixed contacts is arranged at a second side of the actuator, opposite the first side.

7. Switch according to any of the preceding claims, further comprising at least one bridge obtained as a single-piece body, wherein at least two fixed contacts of the same group, are parts of the bridge such as at least two poles of the switch are interconnected in series.

8. Switch according to claim 7 wherein the bridge is U-shaped.

9. Switch according to any of the preceding claims, comprising at least four poles with movable single-plate contacts.

10. Switch according to any of the preceding claims, further comprising an elastic element for each movable single-plate contact, wherein the elastic elements are assembled with the actuator and coupled with their respective movable single-plate contact, and are arranged to urging the movable single-plate contact towards the associated fixed contacts in the closed position of the switch.

11. Switch according to any of the preceding claims, comprising two or more poles interconnected in series, and wherein this group of poles is connected in parallel with an additional pole.

12. Switch according to claim 11, wherein the switch is configured such as the path that the moving contact of the poles interconnected in series (2a,2b,2c), (3a,3b,3c), (4a,4b,4c) must travel until contacting with its respective fixed contacts is shorter than the path that the moving contacts of the additional pole (1 a, 1 b, 1 c) must travel until contacting with its respective fixed contacts, such that in the electrical switch closing operation, the poles interconnected

in series closes before the additional pole.

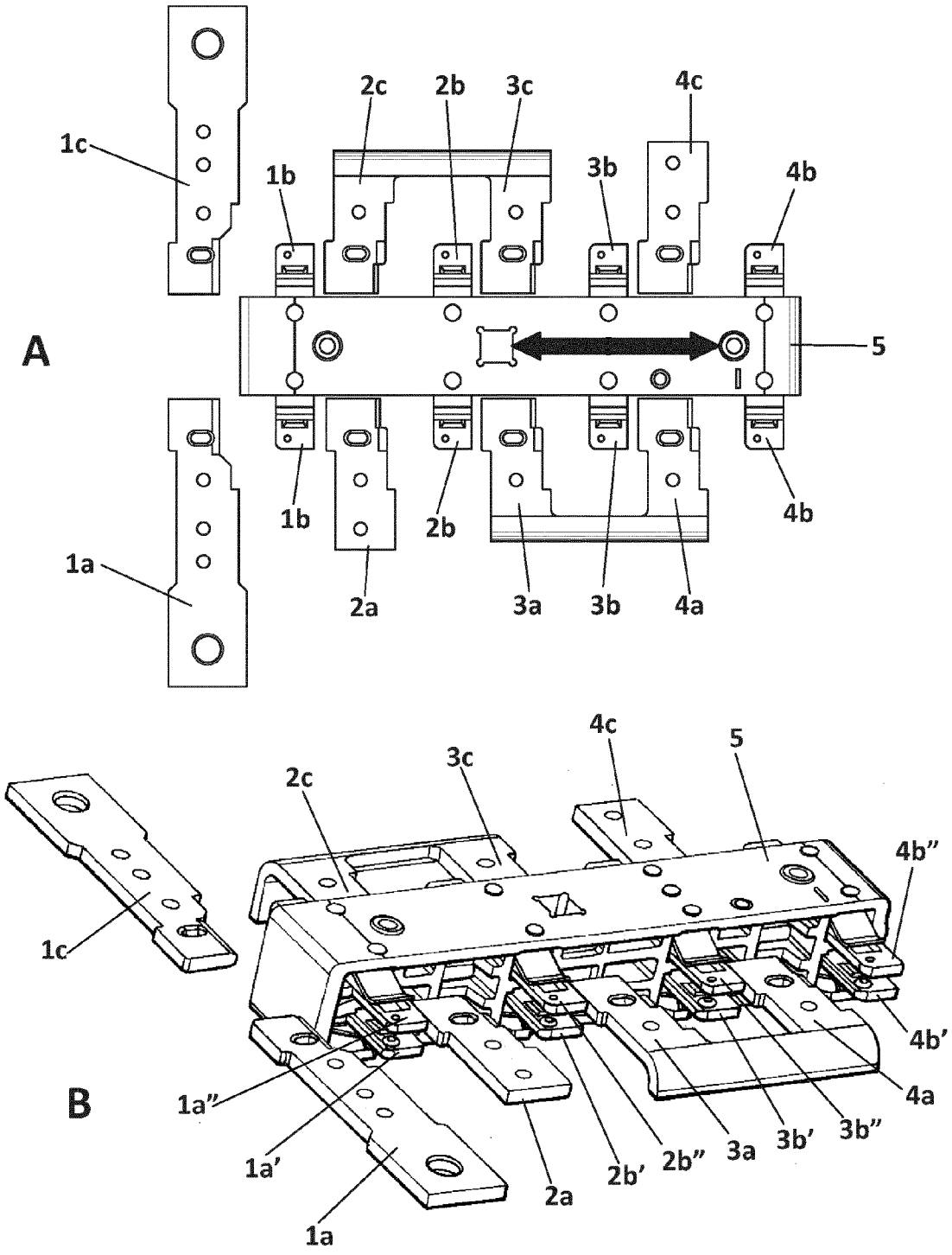

FIG. 1

PRIOR-ART

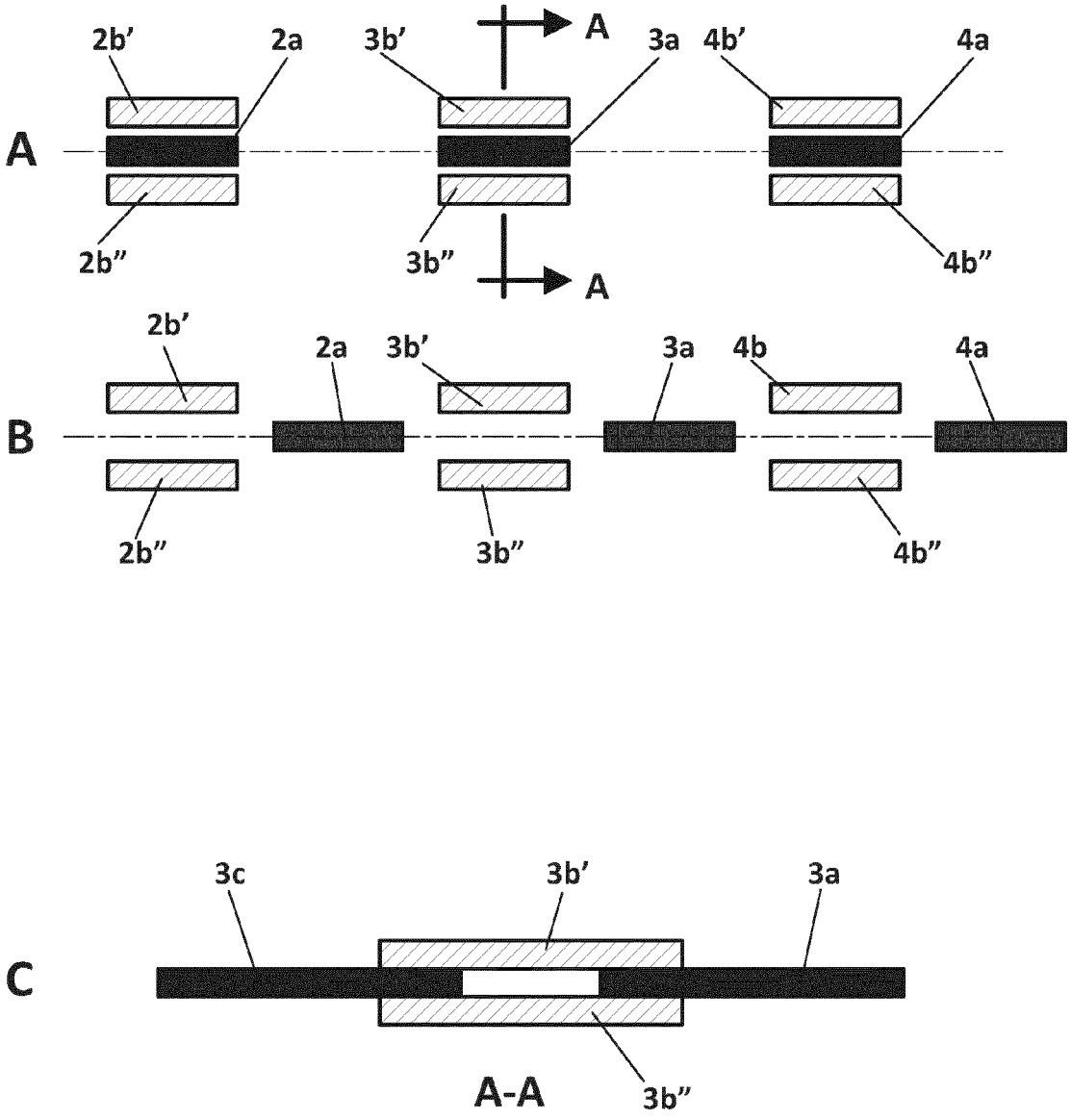

FIG. 2
PRIOR-ART

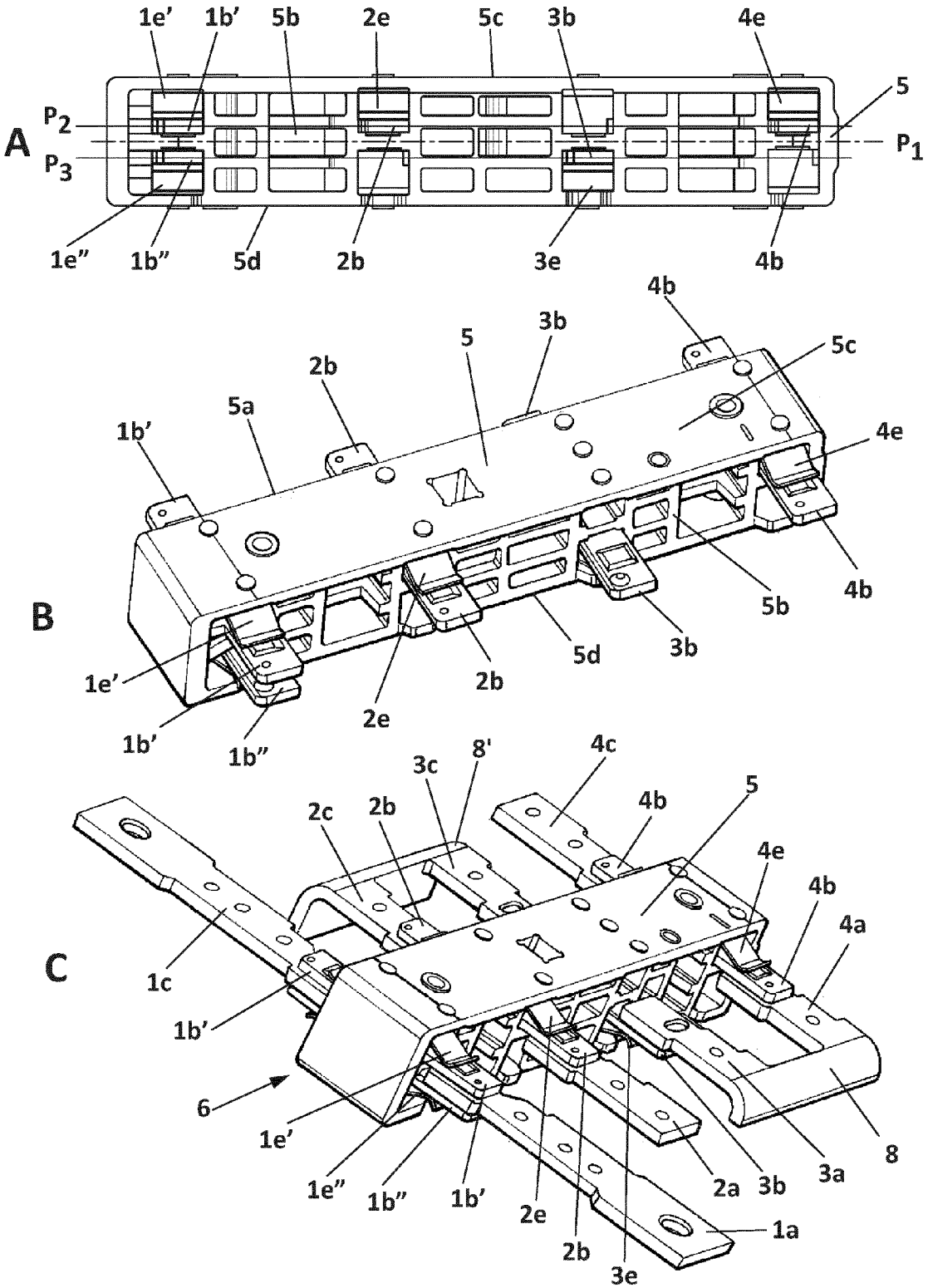
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FIG. 3

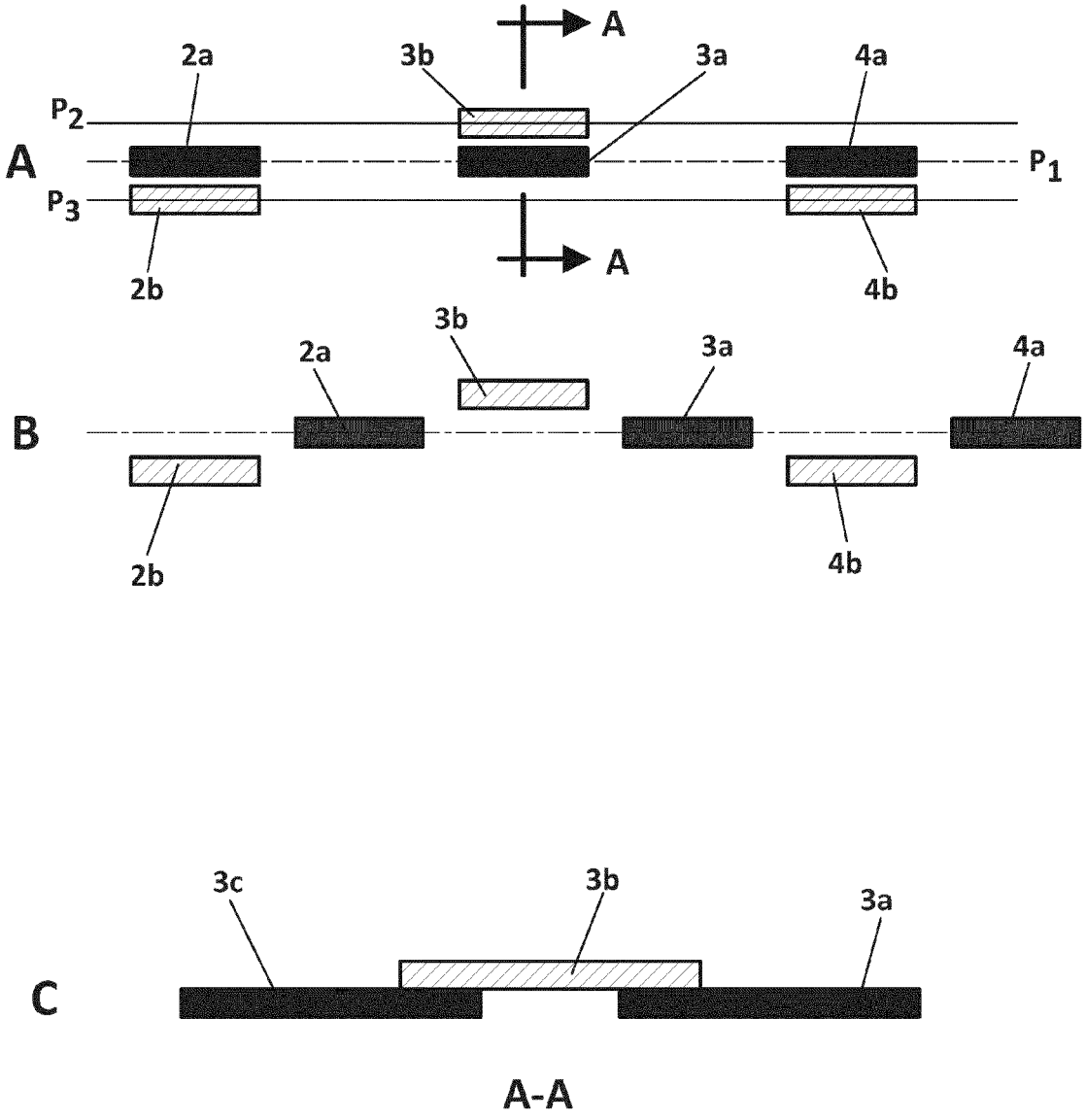

FIG. 4

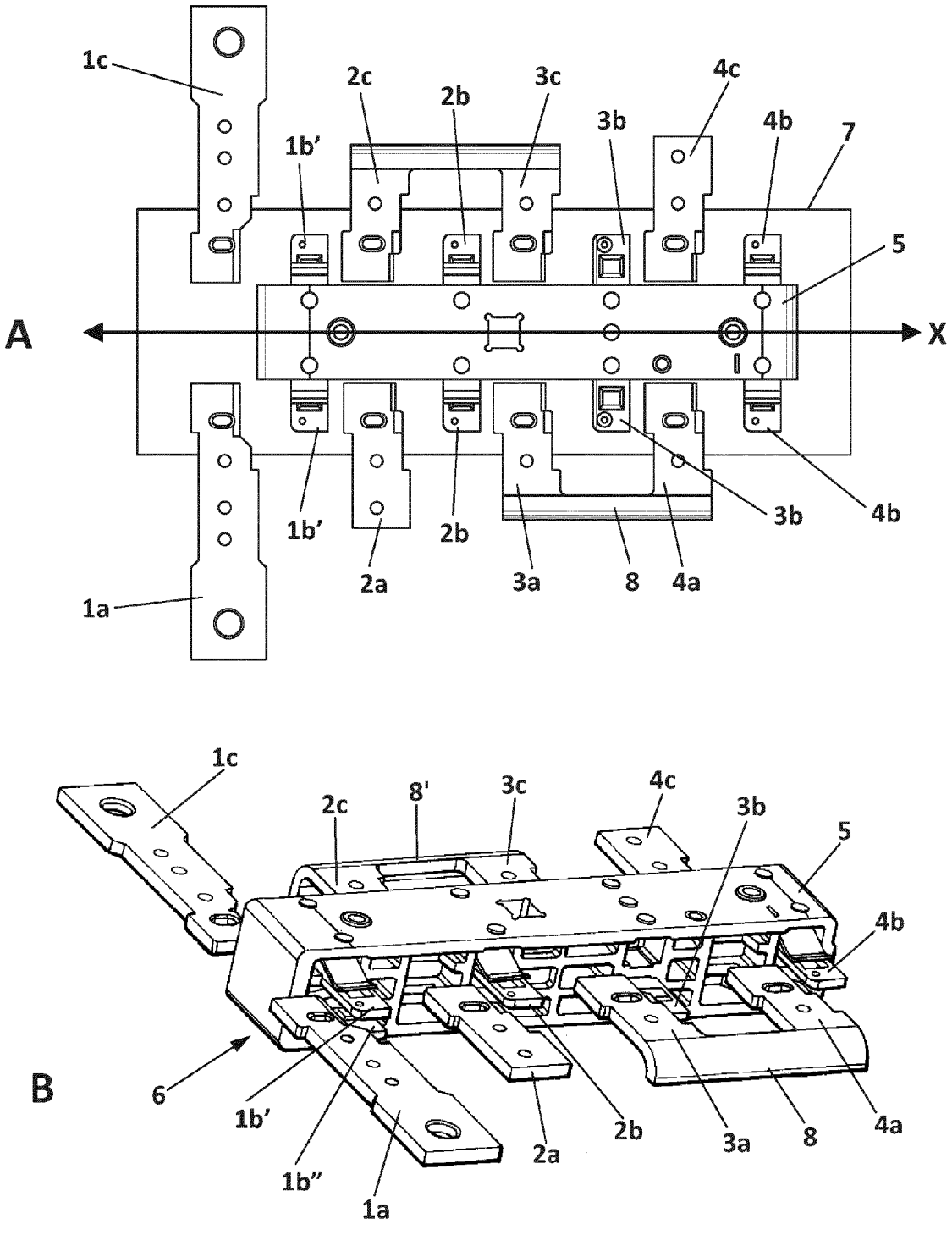
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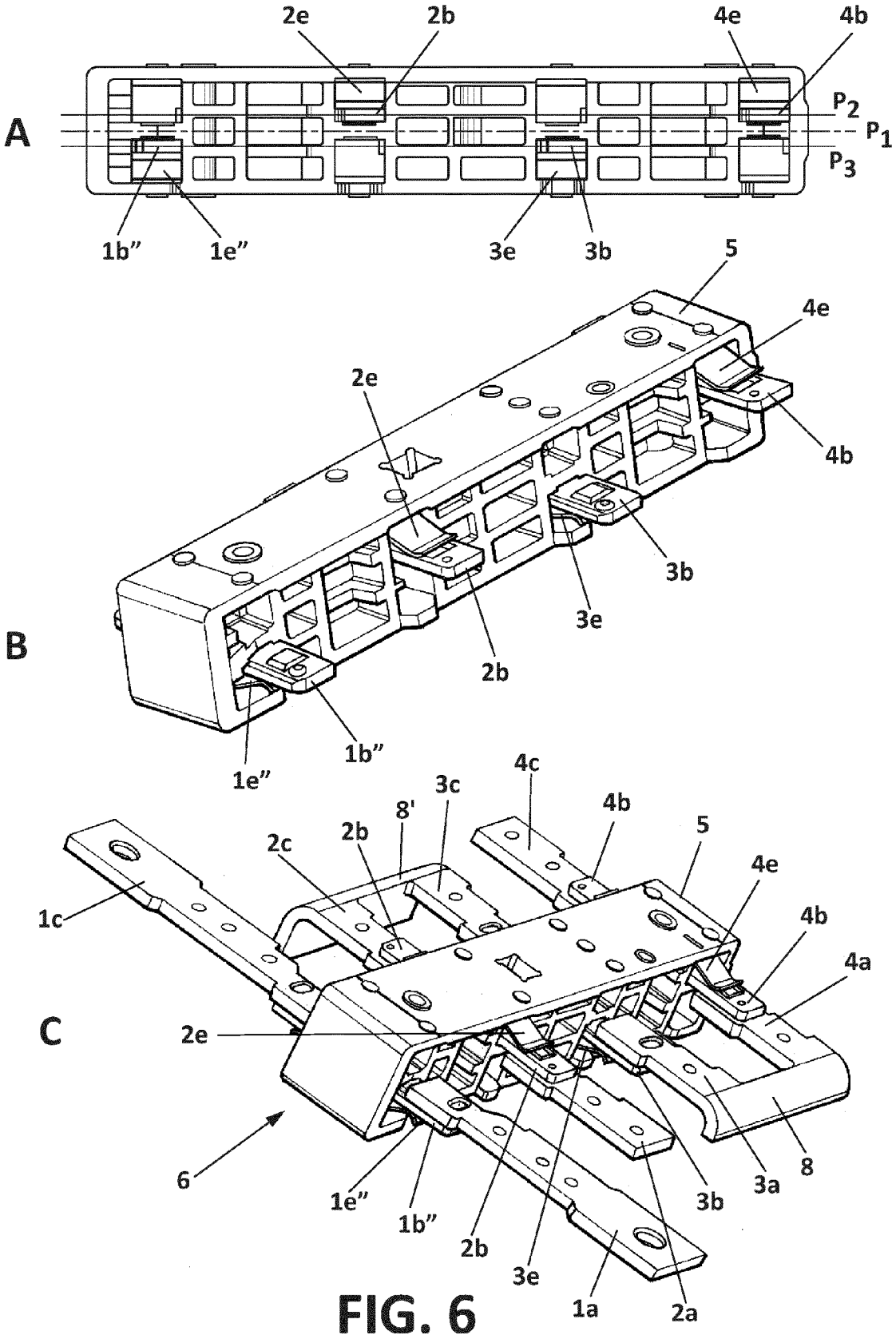
FIG. 5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2a

FIG. 6

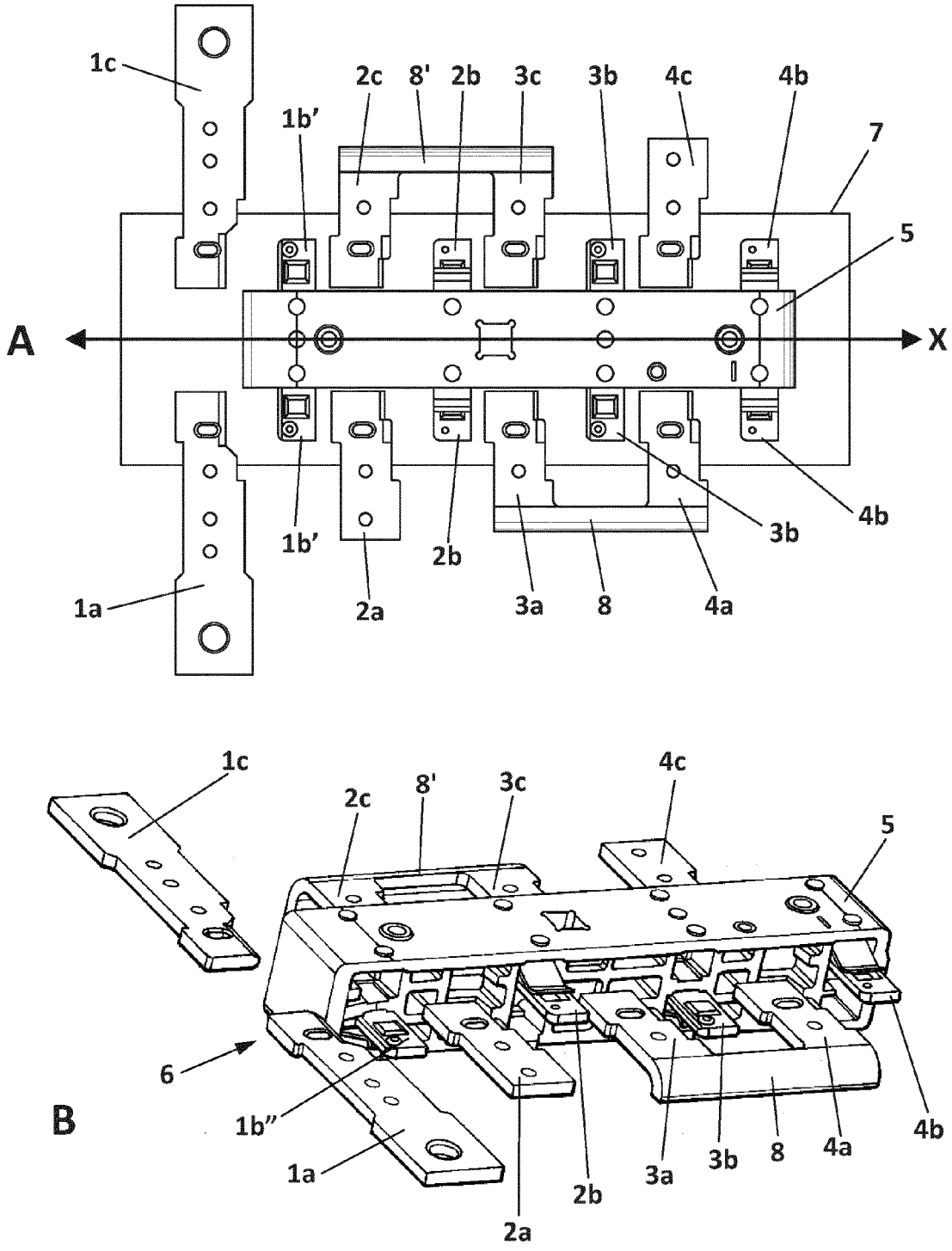
1c
2c
8'
2b
3c
3b
4c
4b
1b'
7
5
A
X
1b'
2b
3b
4b
1a
2a
3a
8
4a
1c
2c
8'
3c
4c
5
6
B
1b"
1a
2b
3a
3b
8
4a
4b
2a

FIG. 7

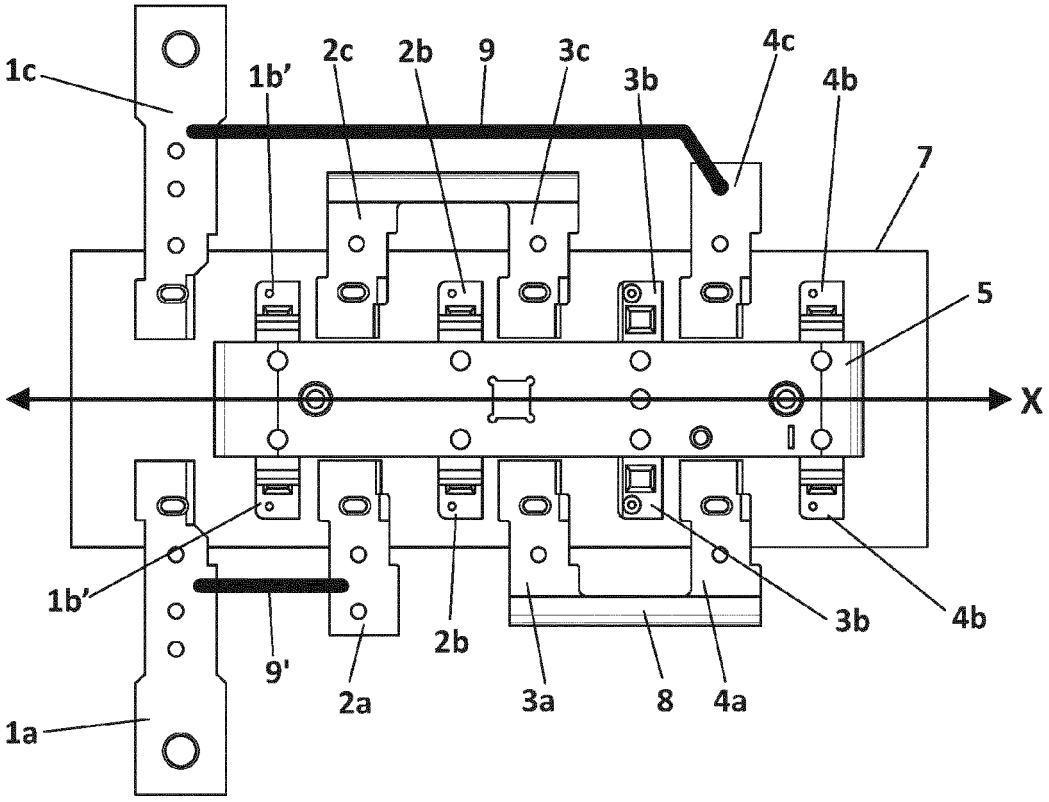

FIG. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 15 38 2143

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	EP 2 667 394 A1 (GORLAN TEAM S L U [ES]) 27 November 2013 (2013-11-27) * abstract *	1-12	INV. H01H15/04 H01H15/06 H01H9/40
A	US 4 778 961 A (M SADOQUES ANDRE J [US] ET AL) 18 October 1988 (1988-10-18) * abstract *	1-12	ADD. H01H1/44 H01H1/58 H01H1/36

TECHNICAL FIELDS SEARCHED (IPC)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 September 2015	Rucha, Johannes

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03-09-2015

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EP 2667394 A1	27-11-2013	NONE	
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