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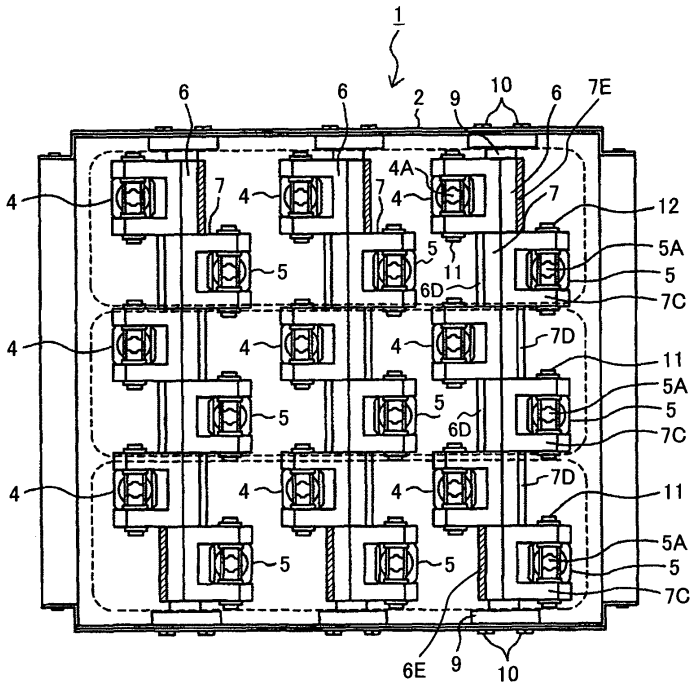
(54) Switching apparatus

(57) A switching apparatus comprising an operating device (1), a main circuit switch (4), and an earthing switch (5), which comprises: a common shaft (8); a first operating lever (6) connected to a movable electrode of the main circuit switch (4) ; and a second operating lever (7) connected to a movable electrode of the earthing switch (5) corresponding to the main circuit switch (4), **characterized in that** the first and second lever are united and stacked around the common shaft alternately, and the levers are being able to turn around the common shaft.

FIG. 1



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Description

FIELD OF THE INVENTION:

[0001] The present invention relates to a switching apparatus for power distribution equipments or power transmission systems, and more particularly to a switching apparatus having a new operating device for operating main circuit switches and earthing switches.

BACKGROUND OF THE INVENTION:

[0002] Conventional vacuum switching apparatuses are quipped with an operating device wherein an opening-closing lever crossing over an operator side, which has a closing coil for driving a closing rod in an axial direction thereof and a circuit breaker side having three vacuum valves for three phases is connected to the circuit breaker side and a shaft extending in a direction perpendicular to the axis of the closing rod. Thus, the three vacuum valves are operated in a synchronizing opening-closing operation. See patent document No. 1, for instance.

[0003] The patent document No. 2 discloses a multi-circuit switching apparatus comprising a mechanical interlocking mechanism for limiting a swing action of a lever in a closing direction of a main circuit switch and an earthing switch, wherein a shaft extending in a horizontal direction is disposed above an operating rod between the main circuit switch and the earthing switch, two levers rotatably supported by the shaft, and two pins for connecting the operating rods of the switches with one ends of the levers (Fig. 11).

[0004] It is necessary to dispose an interlocking mechanism for preventing closing operation of the switches when other switches are closed to the operating levers. For example, the interlocking mechanism comprises a link member connected to a pin and the lever, an interlock pin connected to one end of the link member, and a guide having an ellipse hole thereby moving the interlock pin up and down. When one of the switches is in a closed position, operation of the lever is impossible because of the interference of the interlock pin. Thus, the interlocking mechanism is very complicated. Therefore, a switching apparatus having a simplified interlocking mechanism has been desired.

Patent document No. 1; JP06-89646
Patent document No. 2; JP2006-59557

DESCRIPTION OF THE INVENTION:

[0005] Switching apparatuses for power distribution systems or power transmission systems are provided with earthing switches in order to secure safety at the time of inspection etc thereof, in addition to main circuit switches. Accordingly, the switching apparatuses have a lever device for operating the main circuit switches and a lever device for operating the earthing switches. Therefore, two support shafts for supporting the lever devices are needed.

[0006] As a result, a space for installing the support shafts becomes large and the whole switching apparatuses become large in size.

SUMMARY OF THE INVENTION:

[0007] The present invention was made based upon the above fact, and it has an object to provide a switching apparatus provided with an operating device for main circuit switches and earthing switches for power use in three phases, which can be compact and simplified so that the whole switching apparatus can be made small in size.

[0008] Therefore, it is an object of the present invention to provide a switching apparatus having a simplified operating device structure so that the switching apparatus can be made small in size.

[0009] It is another object of the present invention to provide a switching apparatus having a simplified operating device with a simplified interlocking mechanism.

[0010] In order to achieve the above object of the present invention, the present invention provides a switching apparatus comprising an operating device (1), a main circuit switch (4), and an earthing switch (5), which comprises:

a common shaft (8);
a first operating lever (6) connected to a movable electrode of the main circuit switch (4); and
a second operating lever (7) connected to a movable electrode of the earthing switch (5) corresponding to the main circuit switch (4),

characterized in that the first and second levers are united and stacked around the common shaft alternately, and the operating levers are being able to swing around the common shaft.

[0011] According to the present invention, a structure of the lever devices can be simplified because the lever devices are rotatably supported around a single common shaft. As a result, the whole switching apparatus can be made small in size.

BRIEF DESCRIPTION OF THE DRAWINGS:

[0012]

Fig. 1 is a plan view of a switching apparatus provided with an operating device for main circuit switches and earthing switches of the present invention.
Fig.2 is a top plan view of a unit of the operating device according to one embodiment.
Fig. 3 is a cross sectional view of operating device along the line III in Fig. 2.
Fig. 4 is a cross sectional view of the operating device

along the line IV in Fig. 2.

Figs. 5A to 5C show an assembling process of the operating device according to the one embodiment.

Fig. 6 is a cross sectional view of an operating device of another embodiment in the same way of Fig. 4.

Figs. 7A and 7B show an assembling process of part of the operating device of said another embodiment.

Fig. 8 is a cross sectional view of an operating device of a still another embodiment.

Fig. 9 is a plan view of an operating device of another embodiment of the present invention.

Fig. 10 is a cross sectional view of the operating device along the line III in Fig. 9.

Fig. 11 is a cross sectional view of the operating device along the line IV in Fig. 9.

Figs. 12A to12C show an assembling process of the embodiment of the operating device.

Fig. 13A shows a status of the operating device wherein all of main circuit switches and earthing switches are open.

Fig. 13B shows a status of the operating device wherein the main circuit switches are closed and the earthing switches are open.

Fig. 14 shows a movement of a swing-stopping member of the operating device of the present invention.

Fig. 15 shows a plan view of another embodiment of the operating device.

Fig. 16 is a cross sectional view of the operating device along the line XII in Fig. 15.

Fig. 17 is a cross sectional view of the operating device along the line XIII in Fig. 15.

Figs. 18A and 18B show an assembling process of the operating device of the present invention.

Fig. 19 is a cross sectional view of the operating device of another embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

[0013] The present invention provides following various improvements or modifications of the above-mentioned invention.

[0014] The present invention provides a switching apparatus, wherein the first operating lever is connected to an operating rod of the main circuit switch, and the second operating lever is connected to an operating rod of the earthing switch.

[0015] The invention further provides a switching apparatus, which comprises a desired number of units for desired number of phases, wherein each unit comprises the operating device, the main circuit switch and the earthing switch.

[0016] The present invention provides a switching apparatus, wherein a plurality of main circuit switches are arranged right and left of the common shaft in a direction of the shaft length, and a plurality of the earthing switches are arranged left and right of the common shaft in the direction of the shaft length, the main circuit switches and the earthing switches are arranged alternately.

[0017] The present invention further provides a switching apparatus, wherein the first operating lever comprises a pair of levers (6C) for holding the main circuit switch and a first shaft cover (6A) that covers the common shaft at one end of the first operating lever, and wherein each end of the levers (6C) has a connecting portion (10A) having a connecting hole (6B) for connecting to the operating rod (4).

[0018] The present invention still further provides a switching apparatus, wherein the second operating lever comprises a pair of levers (7C) and a shaft cover (7A) for covering the common shaft at one end of each of the levers, and wherein the other end of each of the operating levers has a connecting portion (11A) having a hole (7B) for connecting to the operating rod of the main circuit switch.

[0019] The present invention provides a switching apparatus, wherein the first shaft cover is connected in the direction of the shaft length via the first connecting member (6D).

[0020] The present invention provides a switching apparatus, wherein the second shaft cover is connected in the direction of the shaft length via the second connecting portion (7D).

[0021] The present invention further provides a switching apparatus, wherein a shaft support (9) is fixed to each end of the common shaft, and wherein the upper end and lower end of the common shaft are positioned by positioning members (6E, 7E) thereby to position the shaft supports, first shaft cover and second shaft cover. The positioning member may limit swing of the operating levers 6, 7 with respect to the shaft 8.

[0022] The present invention provides a switching apparatus according to claim 1, wherein the first operating lever and the first connecting member, and the second operating lever and the second connecting member are united respectively.

[0023] The present invention further provides a switching apparatus, wherein each of the first operating lever and the second operating lever has a semi-circular groove (61A1, 71A1) at one end thereof.

[0024] The present invention provides a switching apparatus, wherein the other end of each of the first operating lever and the second operating lever is a hollow lever (71A), the hollow lever is inserted to cover a connected member of an inner lever (60A, 70A).

[0025] The switching apparatus is composed of the apparatus according to combinations of two or more of the above-mentioned embodiments.

[0026] In the following the present invention will be explained by reference to drawings.

[0027] In Fig. 1 there are three pairs of main circuit switches 4 for three phases and earthing switches 5 each corresponding to each of the main circuit switches in the casing 2 of the switching apparatus 1.

[0028] First operating levers 6 for operating the main

circuit switches 4 for three phases and second operating levers 7 for operating the earthing switches for three phases are arranged alternately along a shaft 8 (Fig. 2) and rotatably disposed coaxially on the shaft 8. The operating levers swing around the shaft 8.

[0029] A structure of the first operating lever and second operating lever will be explained in detail by reference to Figs. 1 through 4.

[0030] The first operating levers 6 each comprises a plurality of shaft covers 6A (three, in this embodiment), levers 6C each being disposed at the shaft cover 7A in such a manner that the lever 6C interests the axis of the shaft cover 6A and having a connecting hole 7B at its end portion, first connecting members 6D disposed between the levers 6C to mechanically connect the lever members 6C, and a positioning member 6E at one end of the shaft 8.

[0031] The second operating member 7 has a similar structure to that of the first operating lever 6, which comprises a plurality of shaft covers 7A, levers 7C each being disposed between the shaft covers 6A in such a manner that the lever 7C interests the axis of the shaft cover 7A and having a connection hole 7B at its end portion, second connecting members 7D disposed between the levers 7C to mechanically connect the lever members 7C and a positioning member 7E at the other end of the shaft 8. The positioning members 6E, 7E support the first operating levers 6 and second operating levers 7 towards the common shaft 8, as shown in Fig. 4. The end of the positioning members 6E, 7E are not in contact with the shaft supporting members 9 in order to secure free movement of the operating members, 6, 7.

[0032] Ends 10A, 11A of the lever portions 6C, 7C have connecting holes 6B, 7B.

[0033] The shaft supports 9 cover the shaft 8 as shown in Fig. 3. The shaft cover6A, 7A are alternately stacked on the common shaft 8.

[0034] The first operating lever 6 having the lever portion 6C and second operating lever 7 having the lever portion 7C are rotatably supported on the common shaft 8 though the shaft hole 6a, 7a and extend in the opposite direction, as shown in Fig. 4. The lever portions 6C, 7C have connecting holes 6B, 7B, respectively.

[0035] The switching apparatus according to the present invention may be provided with a swing action limiting members (16E, 17E), which limit a swing action of the first operating lever (6) and/or the second operating lever (7) around the common shaft (8). The swing action limiting member limits swing action when the operating lever moves by a predetermined angle to prevent closing action of the switches.

[0036] In the switching apparatus according to the present invention, the swing action limiting members (16E, 17E) each has a projection (16i, 17i) that touches the shaft cover (6A, 7A).

[0037] In the switching apparatus according to the present invention, the swing action limiting member (16E, 17E) is disposed at one end of the lever portion.

[0038] The first operating lever 6 for the main circuit switches and the second operating lever 7 for the earthing switches are disposed alternately left and right sides along the common shaft 8. The both ends of the common shaft 8 are inserted into holes of shaft supports 9 and the shaft supports 9 are fixed to inside of the casing 2 by means of bolts 10, as shown in Fig. 1.

[0039] Each operating lever 6C of the first operating levers 6 is connected to an operating rod 4A of the main circuit switch 4 by means of a pin shaft 11, as shown in Fig. 1. Each operating lever 7C of the second operating levers 7 is connected to an operating rod 5A of the earthing switch 5 by means of a pin shaft 12. The first operating lever 6 and the second operating lever 7 are connected to an operator (not shown), which is located vertically above the switching apparatus shown in Fig. 1. The first operating lever 6 and the second operating lever 7 may be united by forming them with casting. In this case, the inner face of holes of the shaft covers 6A, 7A of the first and second operating levers 6, 7 is machined to make the inner surface smooth.

[0040] Then, an assembly process of the operating device will be explained in detail by reference to Figs. 5A to 5C and 6 to 7.

[0041] As shown in Fig. 5A, the first operating lever 6 and second operating lever 7 have a similar structure, but are arranged in an opposite direction.

[0042] The shaft covers 7A of the second operating lever 7 are inserted between the shaft covers 6A of the first operating lever 6 so that the shaft hole 7a of the shaft covers 7A of the second operating lever 7 and the shaft hole 6a of the shaft cover 6A of the first operating lever 6 are coincident.

[0043] The operating levers 6, 7 are assembled in back to back in the direction of an arrow, as shown in Fig. 5A so that a straight shaft hole is formed among the operating levers 6, 7. Then, the common shaft 8 is inserted into the shaft holes 6a, 7a. As a result, the first operating lever 6 and second operating lever 7 are united so that they are able to swing around the common shaft 8.

[0044] Then, shaft supporting members 9 to both ends of the common shaft 8 as shown in Fig. 5C. The operating devices thus assembled are fixed to the inside of the casing 2 by means of bolts 10 to install the operating devices in the casing. Three operating lever devices are installed for one three-phase switching apparatus. The operating device shown in Fig. 5C may move in states shown in Figs. 13A and 13B. When the operating device moves into the state shown by Fig. 13A, the main circuit switches and the earthing switches are open. On the other hand, when the operating device moves into the state shown by Fig. 13B, the main circuit switches are closed and the earthing switches are open.

[0045] The lever portions 6C of the first operating devices 6 installed in the casing 2 are connected to operating rods 4A of the main circuit switches 4 by means of the pin shafts 11. The lever portion 7C of the second operating devices 7 installed in the casing 2 are connect-

ed to operating rods 5A by means of pin shafts. As a result, the first operating lever 6 and second operating lever 7in each phase are operated cooperatively to thereby operate the main circuit switches 4 and earthing switches 5 of each phase synchronously.

[0046] According to the first embodiment described above, the structure of the operating levers can be simplified because the first operating levers 6 for operating movable electrodes of the main circuit switches 4 and the second operating levers 7 for operating the movable electrodes of the earthing switches are arranged alternately and the end portions of lever portions 6A, 7A of the first and second operating levers 6, 7 are supported rotatably around the common shaft 8. As a result, the switching apparatus can be further downsized.

[0047] The first operating lever 6 and second operating lever 7 have the same structure, and they can be manufactured by casting alloy with the same mold so that the production cost can be reduced and number of parts can be reduced.

[0048] Further, since the distance in the axial direction of the shaft between the shaft covers 6A of the first operating levers 6 and the shaft covers 7A of the second operating levers 7 are secured, impact resistance of the operating device is secured.

[0049] If the first operating lever 6 and the second operating lever 7 are united in a casting, deformation or deviation in distance among the levers, etc becomes small so that assembling of the parts is easy.

[0050] Fig. 6 shows a cross sectional view of the operating device of another embodiment of the present invention. Figs. 7A and 7B show an assembling process of the operating device.

[0051] In this embodiment, the top plan view of the operating device is the same as shown in Fig. 2 and the cross sectional view of the operating device along the common shaft is the same as shown in Fig. 3.

[0052] In this embodiment shaft covers 6A and lever portions 6C of the first operating lever 6 and shaft covers 7A and lever portions 7C of the second operating levers 7 are composed of two parts. As shown in Fig. 6, inner lever portions 60A, 70A are insertable into outer lever portions 61A, 71A. The outer lever portion 71A, as well as 61A has the structure shown in Fig. 7A, and the inner lever portions 70A have the structure shown in Fig. 7A. The inner lever portion 60A has the same structure as that of the inner lever portion 70A.

[0053] The inner lever portions 60A, 70A have shaft covers 60A2, 70A2, each of which has a semi-circular groove 70A1 (60A1) extending along the shaft length, and the ends of the lever portions 60A4, 70A4 in opposite side to the semi-circular grooves 70A1, 60A1 have semi-circular grooves 70A3, 60A3. As a result, a shaft hole and a connecting hole are formed by the circular inner lever 70A and the outer lever 71A.

[0054] The outer lever portions 61A, 71A are outer-insertable to the inner lever portions 60A, 70A, and the end portions of the lever 61A, 71A have semi-circular grooves 61A3, 71A3. By outer-inserting the outer lever portions 61A, 71A to the inner lever portion 60A, 70A, a circular hole is formed. The outer lever portions 61A, 71A are made of casting as same as that of the first operating levers 6.

[0055] In this embodiment, as shown in Figs. 7A and 7B, the outer lever portion 61A, 71A are outer-inserted to the inner lever portions 60A, 70A, which are separated by connecting member 7D by a predetermined distance, in a direction of the arrow. Thus, the operating lever devices can be assembles. Advantages of this embodiment are that machining of the inner faces of the connecting holes can be conducted easily. Although, only the second operating lever 7 is shown in Figs. 7A and 7B, the first operating lever 6 can be assembled as in the second operating lever.

[0056] After the assembling of the first and second operating levers in the above process, the first and second operating levers are united by inserting a common shaft through the hole and shaft supports 9 are fixed to the both ends of the shaft 8. The assembled first and second operating levers are fixed to the casing 2 of the switching apparatus 1.

[0057] In this embodiment, the advantages mentioned above with respect to the second embodiment are expected. That is, it is possible to conduct mechanical work of the inner faces of the semi-circular grooves 60A3, 70A3 of the shaft covers 60A4, 70A4.

[0058] There is shown another embodiment in Fig. 8 wherein shaft covers 6A, 7A of the first operating lever 6 and second operating lever 7 and the lever portions 6C, 7C are composed of two parts. Outer lever portions 61A, 71A composed of lever portions having connection holes at the ends thereof and disposed to the shaft covers are outer-inserted to the inner lever portions 60A, 70A each having a rectangular shape in a cross section thereof as shown in Fig. 8.

[0059] According to this embodiment, almost the same advantages as those of the above-mentioned embodiments are expected. That is, it is possible to conduct machine the inner surfaces of the holes formed in the end portions of the outer levers 61A, 71A to be outer-inserted to the inner levers 60A, 71A and the inner faces of the connection holes with ease and high precision.

[0060] In the above embodiments, a size of the shaft covers 6A, 7A in a direction of the shaft of the first operating levers 6 and the second operating levers 7 is the same as that of the lever portions 6C, 7C in the shaft direction, but the size of the shaft covers 6A, 7A in the shaft direction can be made larger than that of the lever portions 6C, 7C in the shaft direction. According to this embodiment, the impact resistance of the operating levers can be further improved to increase reliability thereof.

[0061] Although in the above-described embodiments the positioning members 6E, 7E are attached to the first and second operating levers 6, 7, they can be omitted. The shaft covers 9 may be fixed to the operating levers.

[0062] In the following embodiments the swing action limiting member has a function for prohibiting a swing action of the operating levers around the shaft with respect to the other operating lever. As a result, an interlock mechanism of the switching apparatus can be simplified and the number of parts of the operating device can be reduced.

[0063] A plan view of the switching apparatus according to this embodiment is omitted because the structure of the plan view thereof is the same as that of Fig. 1.

[0064] The plan view of one operating device of this embodiment is shown in Fig. 9, wherein the main parts are the same as those in Fig. 2 except the swing action limiting members 16E, 17E are disposed at the end portions of the operating device. A cross sectional view along the line III in Fig. 9 is shown in Fig. 10, wherein the swing action limiting members 16E, 17E are disposed at the both end sides of the shaft 8. The swing action limiting members 16E, 17E are projected from the operating levers 6, 7 as shown in Figs. 10 and 11. The projected portions are shown as projects (curved portions) 16i, 17i. The swing action limiting member is compose of a straight portion 16h and curved portion 16i. The swing action limiting member 16E is fixed to the second operating lever 7 and the swing action limiting member 17E is fixed to the operating lever 6. The swing action limiting members cover part of the outer peripheries of the shaft covers of the levers 6, 7. The tips of the projects 16i, 17i are opposite to each other as shown in Fig. 11 so that the swing of one of the operating levers 6, 7 is limited with respect to the other operating lever.

[0065] The second operating lever 7 has the same structure as that of the first operating lever 6.

[0066] The first operating lever 6 and the second operating lever 7 are alternately stacked along the common shaft 8, as shown in Fig. 10, wherein the shaft cover portions 6A, 7A have shaft holes 6a, 7a through which the shaft 8 is inserted are stacked.

[0067] Figs. 12A, 12B and 12C show an assembling process of the operating device of this embodiment. At first, the first operating lever 6 having first levers 6C connected by connecting members 6D is provided with the swing action limiting member 16E at one end thereof. The second operating lever 7 having second levers 7C connected by connecting members 7D is provided with the swing action limiting member 17E at one end thereof.

[0068] The swing action limiting member 6E has a curved portion and a straight portion to cover the surface of the shaft cover 7A, and the positioning ember 7E has a curved shape to cover the surface of the shaft cover 6A. The shaft cover portion 6g is inserted into the recess 7f of the second operating lever 7, and the shaft cover portion 7g is inserted into the recess 6f of the first operating lever 6 to constitute the operating device as shown in Fig. 12B.

[0069] The shaft covers 6A are inserted into the gaps between the shaft covers 7A of the second operating lever 7 and the shaft covers 7A are inserted into the gaps between the shaft covers 6A of the first operating lever 6, as shown in an arrow in Fig. 12A. Then, the first and second operating levers 6, 7 are opposed to each other as shown in Fig. 12A and combined to make the shaft hole 6a, 7a.

[0070] The shaft 8 is inserted into the common shaft hole 6a, 7a in the direction of an arrow as shown in Fig. 12B. Thus, the first operating lever 6 and the second operating lever 7 are supported by the common shaft 8 being able to swing around the shaft.

[0071] Thereafter, as shown in Fig. 12C, shaft supports 9 are fixed to both ends of the common shaft 8 to constitute a unit operating device, and three units of the operating devices are installed in the casing 2 side by side by means of bolts 10 as shown in Fig. 1 to constitute the three phase switching apparatus of the present invention.

[0072] Fig. 13A shows a perspective view of the unit of the operating device, which indicates a status where the main circuit switches and the earthing switches are open. Fig. 13B shows a perspective view of the unit of the operating device, which indicates a status where the main circuit switches are open and the earthing switches are closed.

[0073] Fig. 14 is a diagram showing a movement of the levers 6, 7 and the swing action limiting member 16E. The swing action limiting member 16E limits a swing action of the levers 6, 7 around the common shaft 8. Operation of the swing action limiting member 16E will be explained in detail later.

[0074] The lever portion 6C of the first operating lever 6 installed in the casing 2 is connected to the operating rod 4A of the main circuit switch 4 by means of the pin 11. The lever portion 7C of the second operating lever 7 is connected to the operating rod 5A by means of pin 12. As a result, the first operating levers 6 and the second operating levers 7 of the respective phases move synchronously to thereby operate the main circuit switches 4 and the earthing switches 5 altogether in three phases.

[0075] Fig. 13A shows a status that all the switches 4, 5 are open wherein an angle constituted by the lever portion 6C of the first operating lever 6 and the lever portion 7C of the second operating lever 7 is about 180 degrees as shown in Fig. 11.

[0076] The projection 16i of the swing action limiting member 16E of the first operating lever 6 is located with a gap around the periphery of the shaft cover 7A of the second operating lever 7. Similarly, the projection 17i of the swing action limiting member 16E of the second operating lever 7 is located with a gap around the periphery of the shaft cover 6A of the second operating lever 6.

[0077] Fig. 13B shows a perspective view of the operating device wherein the main circuit switches 4 are open and the earthing switches 5 are closed. An angle constituted by the lever portion 6C of the first operating lever 6 and the lever portion 7C of the second operating lever 7 is over 180 degrees, wherein the lever portion 6C of the first operating lever 6 and the operating rod 4A are pressed down to connect a movable contact and a fixed

contact of a main circuit switch. The angle is decided in accordance with the gap between the movable contact and the fixed contact of the main circuit switch 4.

[0078] As shown in Fig. 13B, if the lever portion 6C of the first operating lever 6 swings in an anticlockwise direction, the tip of the projection 16i of the swing action limiting member 16E (swing movement limiting member in this embodiment) contacts with the outer periphery of the shaft cover 7A of the second operating lever 7 and the swing action limiting member 16E limits movement of the second operating lever 7 for operating the earthing switches in a clockwise direction. Similarly, the tip of the projection 17i of the swing action limiting member 17E (swing limiting member in this embodiment) contacts with the outer periphery of the shaft cover 6A of the first operating lever 6 and limits movement of the second operating lever 7 for operating the earthing switches in a clockwise direction. Thus, the closing operation of the earthing switches 5 is locked.

[0079] When the main circuit switches 4 are open and the earthing switches 5 are closed, the tip of the projection 16i of the swing action limiting member 16E of the first operating lever 6 contacts with the outer periphery of the shaft cover 7A of the second operating lever 7 to thereby the swing action limiting member 16E limits a swing action of the first operating lever 6 for operating the main circuit switches 5.

[0080] Similarly, the tip of the projection 17i of the swing action limiting member 17E of the second operating lever 7 contacts with the outer periphery of the shaft cover 6A of the first operating lever 6 to thereby limit a swing action of the first operating lever 6 for operating the main circuit switches 4 in a clockwise direction. As a result, the closing operation of the main circuit switches 4 is locked.

[0081] Relationships between a length of the projection 16i of the swing action limiting member 16E and a swing angle of the first operating lever 6 will be explained by reference to Fig. 14.

[0082] Fig. 14 is a side view of the operating device shown in Fig. 13A in solid lines, and a side view of the operating device shown in Fig. 13B is shown in dotted lines. In Fig. 10, L is a length of the lever portion 6C, which is a length between the center of the connecting hole 6B and the center of the shaft hole 6a. θ is a swing angle of the first operating lever 6, which is a swing angle from the vertical line in the center of the shaft hole 6a at the time when the tip of the projection 16i contacts with the outer periphery of the shaft cover 7A of the second operating lever 7. x is a moving distance of the first operating lever 6 in up and down directions, which corresponds to the gap between the movable contact and the fixed contact of the main circuit switches.

[0083] In the movement of the swing action limiting member (swing movement limiting member), the swing angle θ and the up-and-down movement distance x of the lever 6 are determined in accordance with the following equation (1).

$$x = L \times \tan\theta \cdots\cdots (1)$$

[0084] The symbol x is determined by the gap between the movable contact and the fixed contact, and the swing angle θ is determined by the length L of the lever portion 6C of the first operating lever 6. Accordingly, the length L should be such that the tip of the projection 16i of the swing action limiting member 16E touches the outer periphery of the shaft cover 7A of the second operating lever 7, when the first operating lever 6 swings by the swing angle θ. Although Fig. 14 shows only the swing action limiting member 16E of the first operating lever 6, the swing action limiting member 17E having the projection 17i is formed in the same way as of the swing action limiting member 16E.

[0085] As explained above, though it is necessary to change the swing angles of the lever portions 6C, 7C of the first and second operating levers 6, 7 in accordance with gaps between the movable contacts and the fixed contacts of the switches 4, 5, it is possible to easily change the swing angle θ of the lever portions 6C, 7C by adjusting the length of the projections 16i, 17i of the swing action limiting members 16E, 17E.

[0086] According to the above embodiment, the number of the parts of the operating device will be reduced because an additional interlock mechanism for the main circuit switches and earthing switches, which is necessary for securing safety of the switching apparatus in case of the previous embodiments whose swing action limiting member has no swing limiting function.

[0087] Since it is possible to easily change the swing angle θ of the operating levers 6, 7 by adjusting the length of the tong form projections 16i, 17i of the swing action limiting members 16E, 17E, the operating device of this embodiment can be applied to various switching apparatuses having different gaps between the movable contacts and the fixed contacts without changing basic structure of the operating device. As a result, production cost of the switching apparatuses with a reduced number of parts can be provided.

[0088] Further, the first operating lever 6 and the second operating lever 7 have the same structure, and hence they can be produced by using the same casting mold, thereby to reducing production cost.

[0089] If the first operating lever 6 and the second operating lever are united as a casting, deformation of the operating device can be minimized, and assembling of the switching apparatus becomes easy.

[0090] Figs. 15, 16, 17, 18A, 18B and 19 show another embodiment. Fig. 15 is a plan view of one unit of the operating device, which corresponds to Fig. 2. This embodiment corresponds to that shown in Figs. 7A, 7B.

[0091] Fig. 16 is a cross sectional view along the line XII in Fig. 15, which corresponds to Fig. 3. The swing action limiting member (swing movement limiting mem-

ber) 16E, 17E has projections 16i, 17i as shown in Fig. 16.

[0092] Fig. 17 is a cross sectional view along the line XIII in Fig. 15. Since the shaft covers 6A, 7A of the first operating lever 6 and the second operating lever 7 are constituted by two parts, i.e. inner lever portions 60A, 70A and outer lever portions 61A, 71A, which are outer-insertable to the inner lever portions.

[0093] The inner lever portions 60A, 70A each has shaft cover 60A2, 70A2 with a semi-circle having a semi-circular groove 60A1, 70A1 at the shaft cover side. The inner lever portions 61A, 71A each has lever portion 60A4, 70A4 having a semi-circular groove 60A3, 70A3 at the end of thereof.

[0094] The outer lever portions 61A, 71A are outer-insertable to the inner lever portions 60A, 70A as shown in Figs. 18A and 18B. The outer lever portions 61A, 71A each has the semi-circular shaft cover 61A2, 71A2 having a semi-circular groove 61A1, 71A1 and the lever portions 61A4, 71A4 having the semi0circular groove 61A3, 71A3 at the end of the lever portion 61A, 71A. The outer lever portions 61A, 71A can be produced by casting as same as the first operating lever 6 and the second operating lever 7.

[0095] In this embodiment, the inner lever portions 70A are connected with connecting members 7D. An outer lever portions 71A are outer-inserted to the inner lever portions as shown in Fig. 18B to constitute the second operating lever 7. The first operating lever 6 is constituted by the same manner as shown in Figs. 18A and 18B. After preparation of the first and second operating levers 6, 7, they are arranged in the manner shown in Figs. 5A and 12A, and the shaft cover portions of the first operating member 6 are inserted into between the shaft cover portions of the second operating lever as shown in Figs. 5B and 12B. Then, the common shaft 8 is inserted into the shaft hole as shown in Figs. 5B and 12B. Thereafter, the shaft supports 9 are fixed to both ends of the shaft 8 as shown in Figs. 5C and 12C.

[0096] After the units of the operating devices are prepared, they are installed in the casing 2 by means of pins 10 as shown in Fig. 1.

[0097] In this embodiment, the advantages of the previous embodiments are expected. Further, in this embodiment, the machining of the inner faces of the semi-circular grooves 60A1, 70A1, 60A3, 70A3 are conducted very easily.

[0098] As another example wherein the shaft covers 6C, 7C and the lever portions 6C, 7C of the first and second operating levers 6, 7, there is shown a cross sectional view in Fig. 19. This embodiment corresponds to Fig. 8. The operating device is composed of the inner lever portions 60A, 70A with a rectangular shape and outer lever portions 60A, 70A, which are outer-insertable to the inner lever portions 61A, 71A.

[0099] According to this embodiment, the same advantages of the embodiment shown in Fig8. The machining of the inner faces of the grooves of the outer lever portions and the inner lever portions is easily conducted.

[0100] In this embodiment, the swing action limiting member 16E, 17E are disposed at the outside of the lever portion 6C, 7C as shown in Figs. 2, 9, 15. However, the swing action limiting members can be disposed inside of the lever portions 6C, 7C. The swing action limiting members 16E, 17E are disposed to each of the first and second operating levers 6, 7; but at least one swing action limiting member for one of the operating levers is enough for limiting the swing action.

[0101] The tong form projections 16i, 17i of the swing action limiting member 16E, 17E are formed to cover the part of the outer periphery of the shaft cavers, wherein the member has a plate having a semi-circle with a radius of curvature of the shaft hole 6a, but the circular plate may be substituted with a L-shape plate that covers the shaft covers. The L-shaped plate may have tips of the projections 16i, 17i that touch the outer periphery of the shaft covers.

Claims

1. A switching apparatus comprising an operating device (1), a main circuit switch (4), and an earthing switch (5), which comprises:

   a common shaft (8);
   a first operating lever (6) connected to a movable electrode of the main circuit switch (4); and
   a second operating lever (7) connected to a movable electrode of the earthing switch (5) corresponding to the main circuit switch (4),
   characterized in that the first and second operating levers are united and stacked around the common shaft alternately, and the operating levers are being able to swing around the common shaft.

2. The switching apparatus according to claim 1, wherein the first operating lever is connected to an operating rod of the main circuit switch, and the second operating lever is connected to an operating rod of the earthing switch.

3. The switching apparatus according to claim 1 or 2, which comprises a desired number of units for desired number of phases, wherein each unit comprises the operating device, the main circuit switch and the earthing switch.

4. The switching apparatus according to any of claims 1 to 3, wherein a plurality of main circuit switches are arranged right and left of the common shaft in a direction of the shaft length, and a plurality of the earthing switches are arranged left and right of the common shaft in the direction of the shaft length, the main circuit switches and the earthing switches are arranged alternately.

5. The switching apparatus according to any of claims 1 to 4, wherein the first operating lever comprises a pair of levers (6C) for holding the main circuit switch and a first shaft cover (6A) that covers the common shaft at one end of the first operating lever, and wherein each end of the levers (6C) has a connecting portion (10A) having a connecting hole (6B) for connecting to the operating rod (4).

6. The switching apparatus according to any of claims 1 to 5, wherein the second operating lever comprises a pair of levers (7C) and a shaft cover (7A) for covering the common shaft at one end of each of the levers, and wherein the other end of each of the operating levers has a connecting portion (11A) having a hole (7B) for connecting to the operating rod of the main circuit switch.

7. The switching apparatus according to claim 5, wherein the first shaft cover is connected in the direction of the shaft length via the first connecting portion (6D).

8. The switching apparatus according to claim 6, wherein the second shaft cover is connected in the direction of the shaft length via the second connecting portion (7D).

9. The switching apparatus according to any of claims 1 to 8, wherein a shaft support (9) is fixed to each end of the common shaft, and wherein the upper end and lower end of the common shaft are positioned by positioning members (6E, 7E) thereby to position the shaft supports, first shaft cover and second shaft cover.

10. The switching apparatus according to any of claims 1 to 9, wherein the first operating lever and the first connecting member, and the second operating lever and the second connecting member are united respectively.

11. The switching apparatus according to any of claims 1 to 10, wherein each of the first operating lever and the second operating lever has a semi-circular groove (61A1, 71A1) at one end thereof.

12. The switching apparatus according to claim 11, wherein the other end of each of the first operating lever and the second operating lever is a hollow lever (71A), the hollow lever is inserted to cover a connected member of an inner lever (60A, 70A).

13. The switching apparatus according to any of claims 1 to 12, which further comprises a positioning member (16E, 17E), which limits a swing movement of the first operating lever (6) or the second operating lever (7) around the common shaft (8).

14. The switching apparatus according to claim 13, wherein
the positioning member (16E, 17E) has a projection (16i, 17i) that touches the shaft cover (6A, 7A), and/or
the positioning ember (16E, 17E) is disposed at one end of the lever portion, and/or
the swing action limiting member is disposed to the side of the lever portion at the end of the operating device, and/or
the swing action limiting member has a straight portion and a curved portion to cover part of an outer periphery of the shaft cover, and/or
the swing action limiting member has a projection that touches the outer periphery of the shaft cover when the operating lever rotates by a predetermined angle, and/or
the curved portion of the swing action limiting member has the same radius of curvature as that of the shaft cover, the center of the curved member being the same as that of the shaft, and/or
the swing action limiting member is composed of two plates to constitute L-form for covering part of the outer periphery of the shaft cover.

15. The switching apparatus according to any of claims 1 to 14, wherein the first operating lever is connected to the movable contact via an operating rod and the second operating lever is connected to the movable contact via another operating rod.

FIG. 1

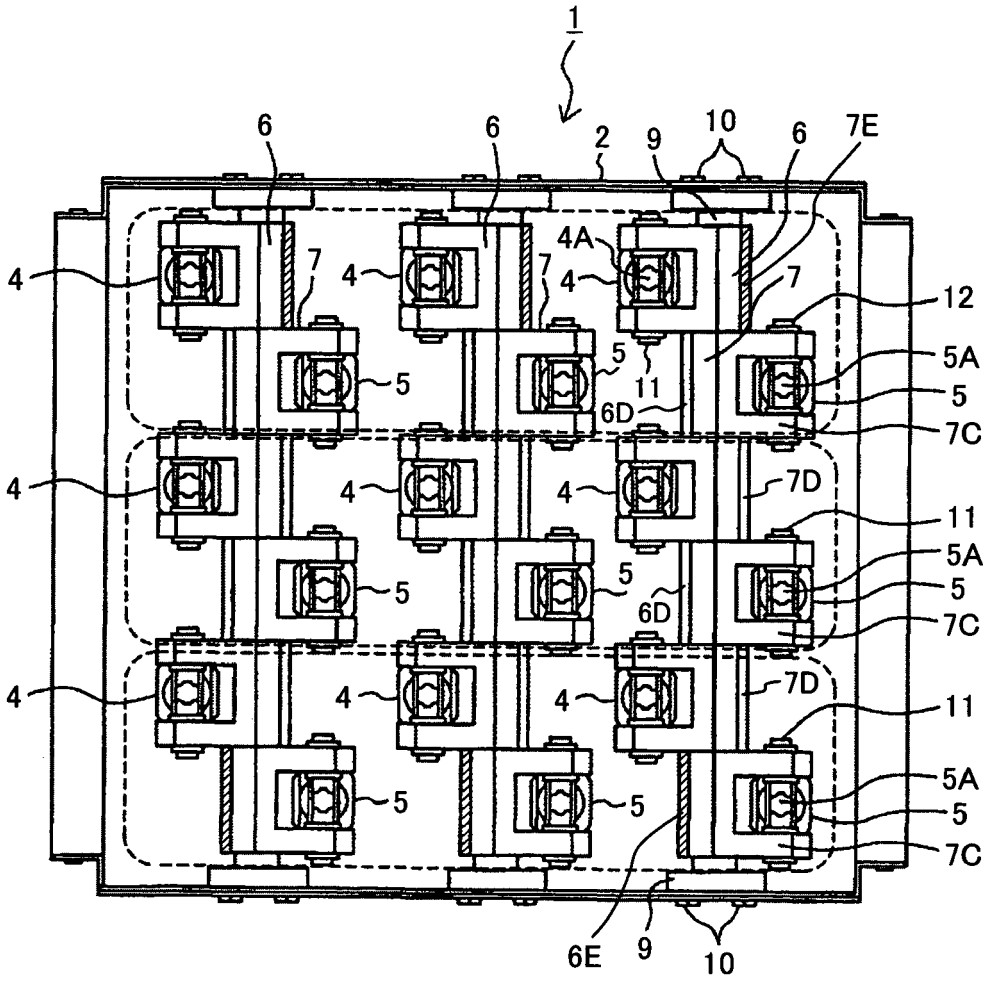

1
6
6
2
9
10
6
7E
4
7
4
7
4
4A
7
12
5
5A
5
11
6D
7C
4
4
4
7D
11
5A
5
6D
7C
4
4
4
7D
11
5A
5
7C
6E
9
10

FIG. 2

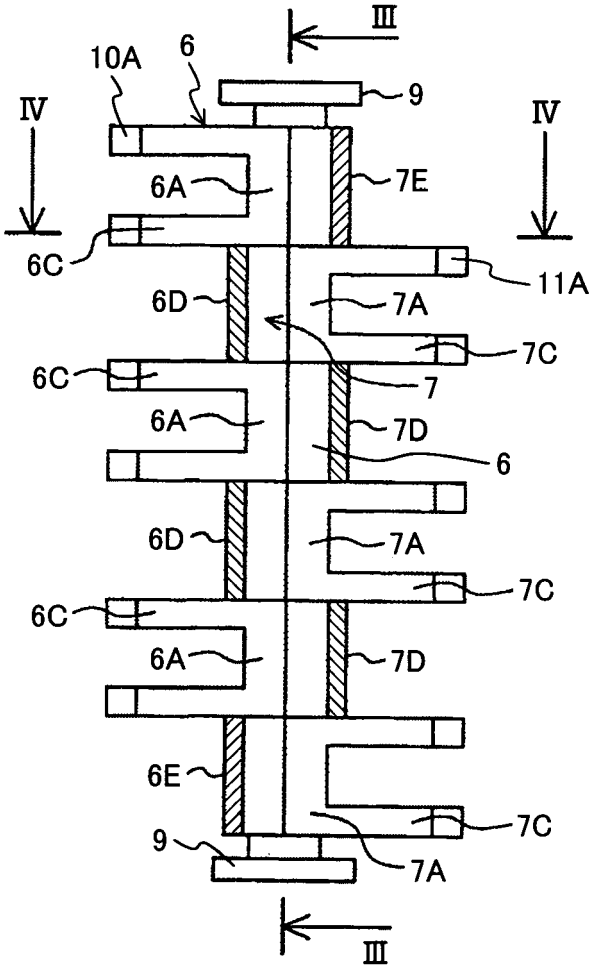

III
10A
6
9
IV
IV
6A
7E
6C
11A
6D
7A
7C
6C
7
6A
7D
6
6D
7A
7C
6C
6A
7D
6E
7C
9
7A
III

FIG. 3

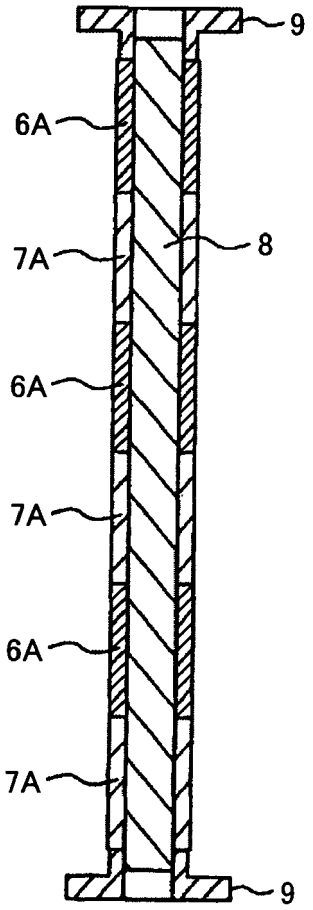


FIG. 4

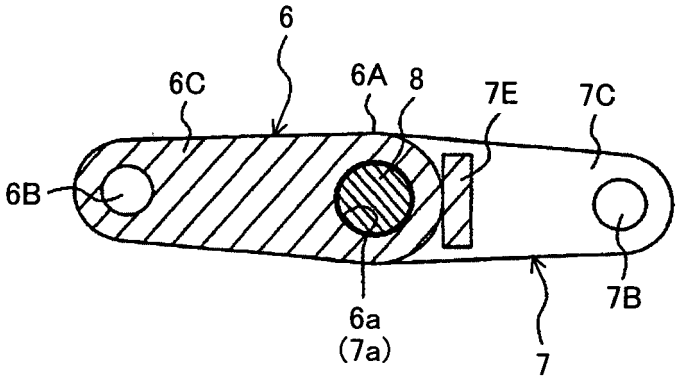

6
6C
6A
8
7E
7C
6B
6a
(7a)
7
7B

FIG. 5A

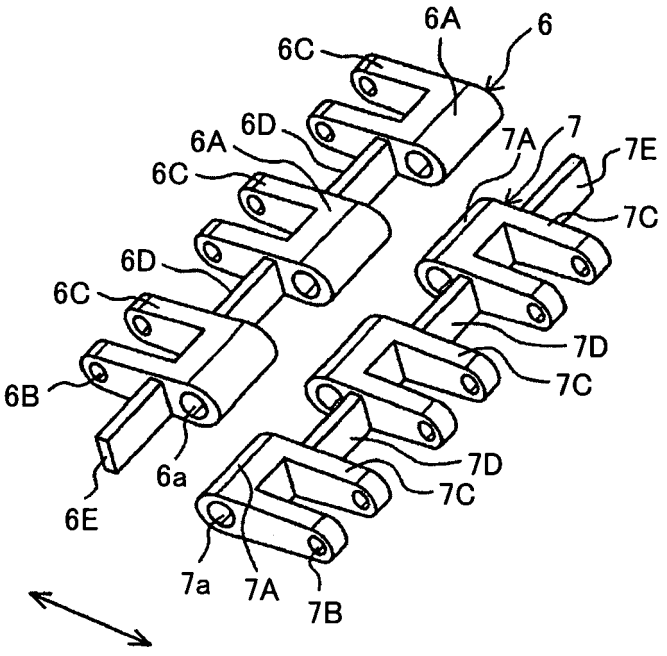

6A
6
6C
6D
6A
7A
7
7E
6C
7C
6D
6C
7D
6B
7C
7D
6a
7C
6E
7a
7A
7B

FIG. 5B

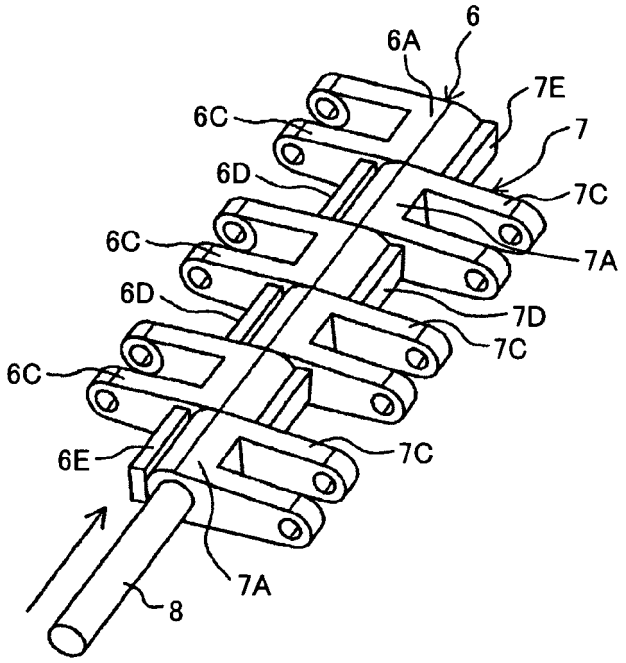

6
6A
7E
6C
7
6D
7C
6C
7A
6D
7D
7C
6C
6E
7C
7A
8

FIG. 5C

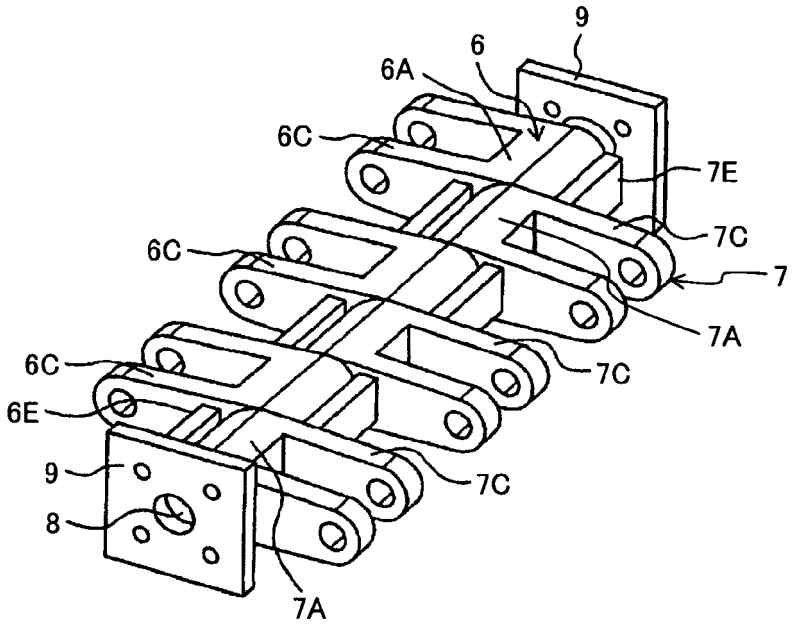

9
6
6A
6C
7E
7C
6C
7
7A
6C
7C
6E
9
7C
8
7A

FIG. 6

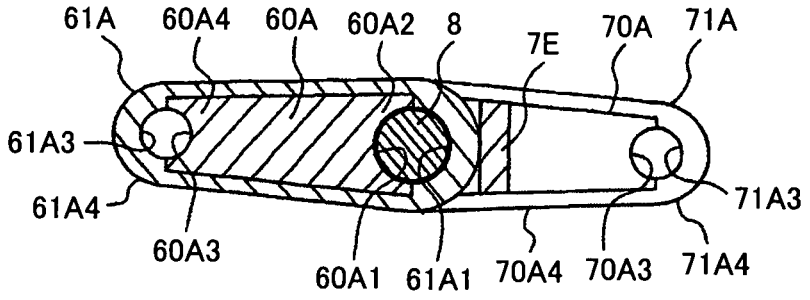

61A
60A4
60A
60A2
8
7E
70A
71A
61A3
61A4
71A3
60A3
60A1
61A1
70A4
70A3
71A4

FIG. 7A

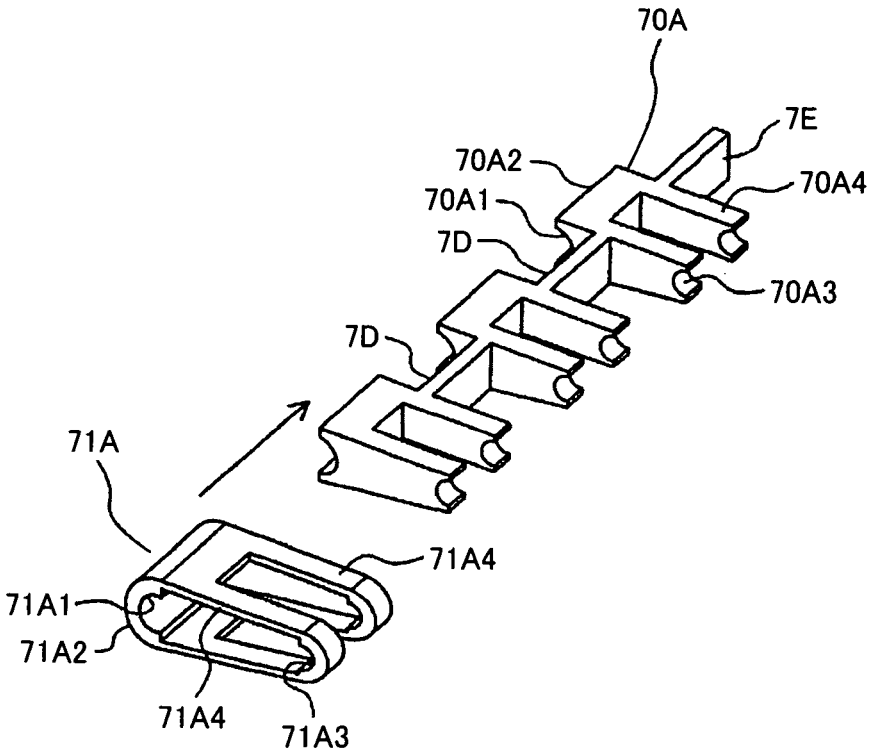

70A
7E
70A2
70A4
70A1
7D
70A3
7D
71A
71A4
71A1
71A2
71A4
71A3

FIG. 7B

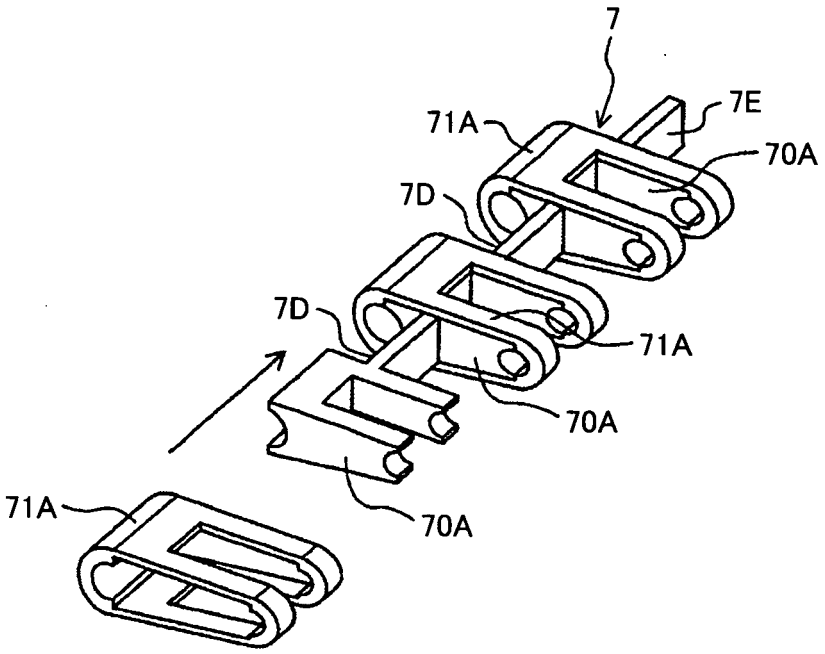


FIG. 8

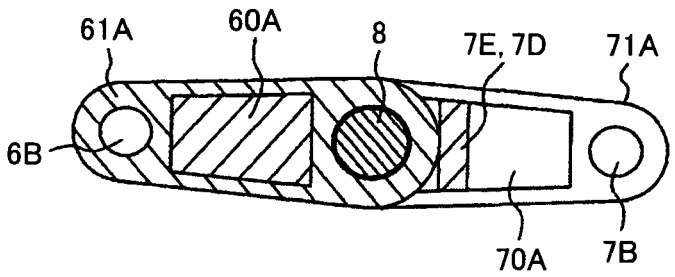


FIG. 9

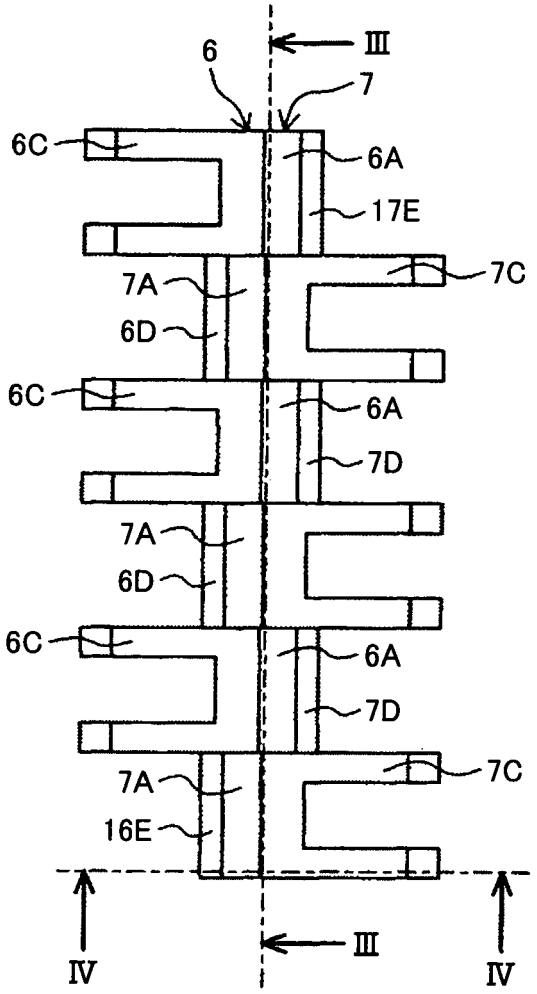


FIG. 10

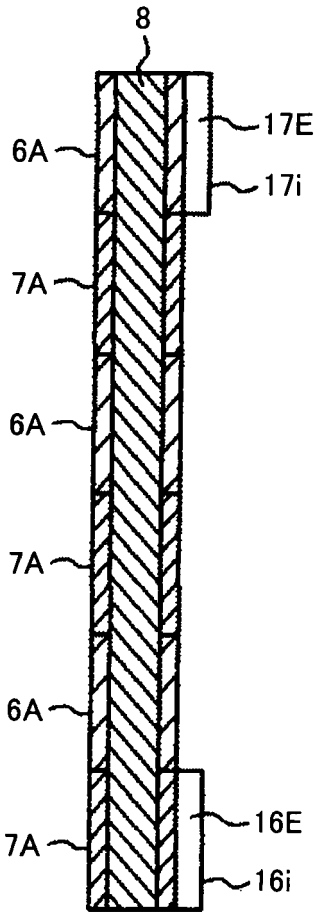


FIG. 11

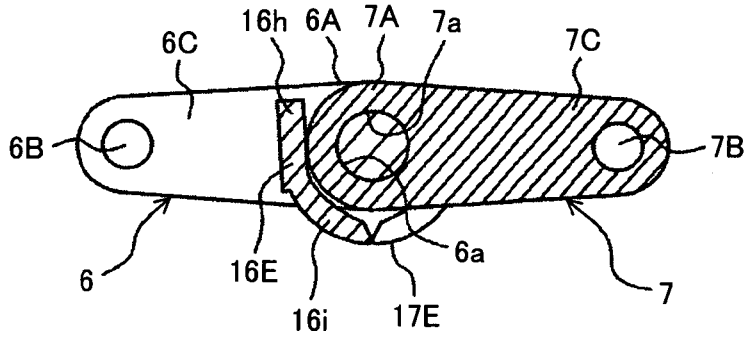


FIG. 12A

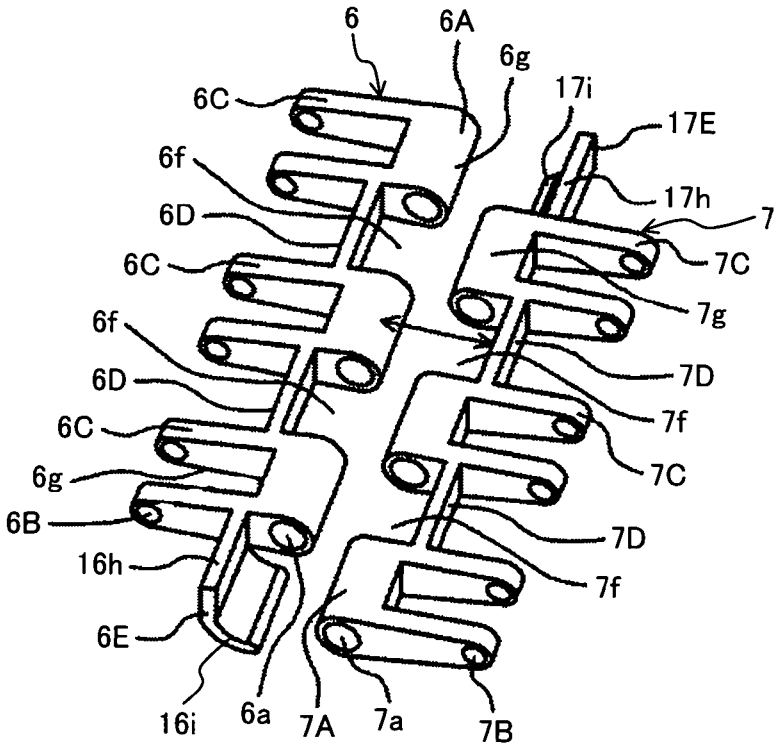


FIG. 12B

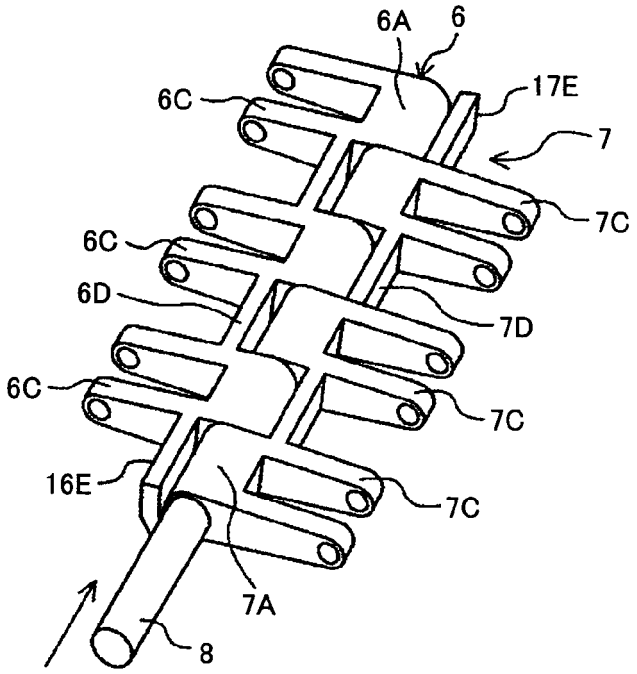


FIG. 12C

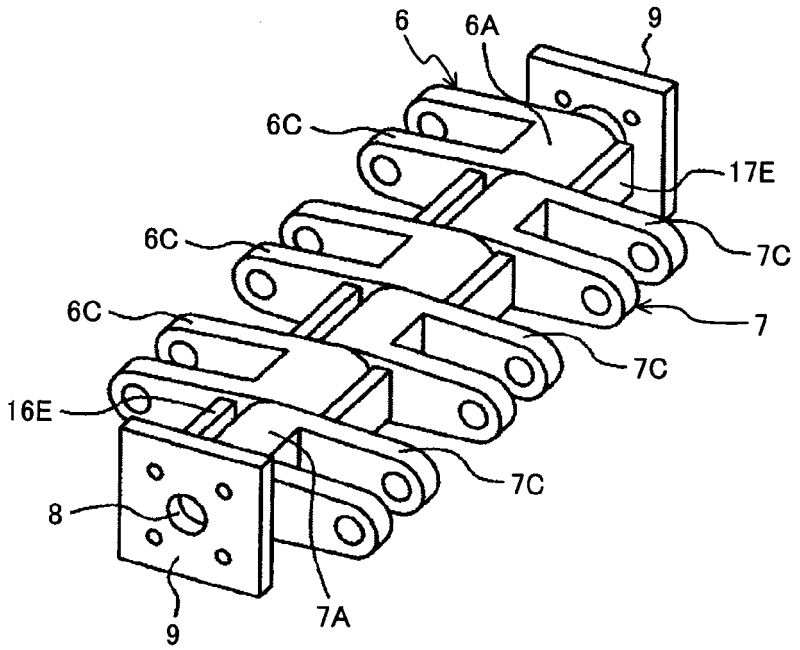


FIG. 13A

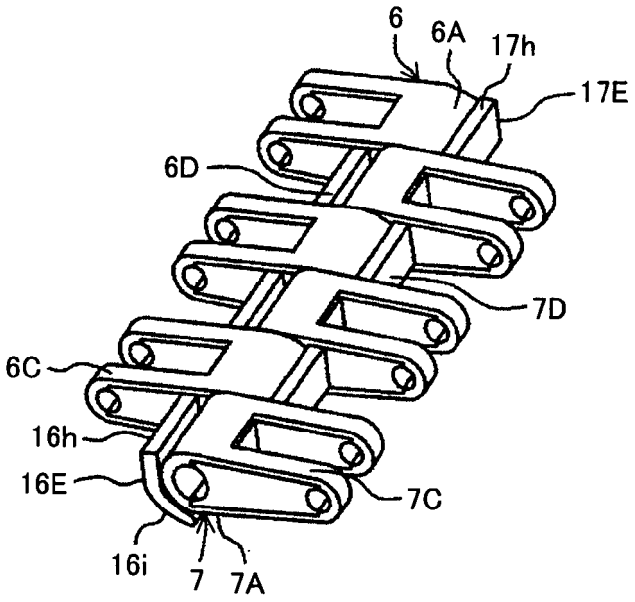


FIG. 13B

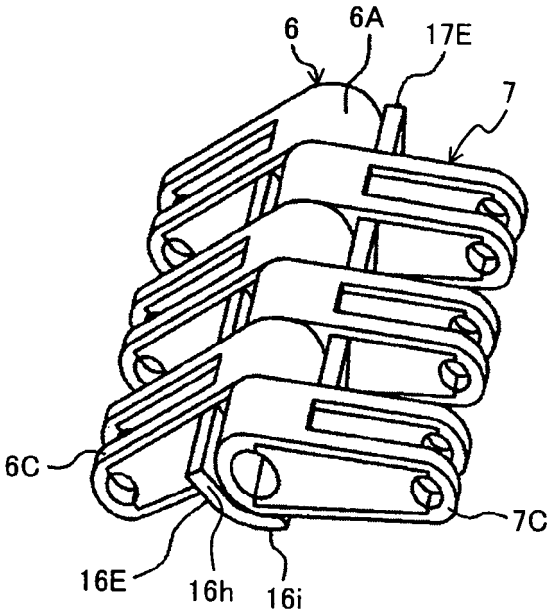


FIG. 14

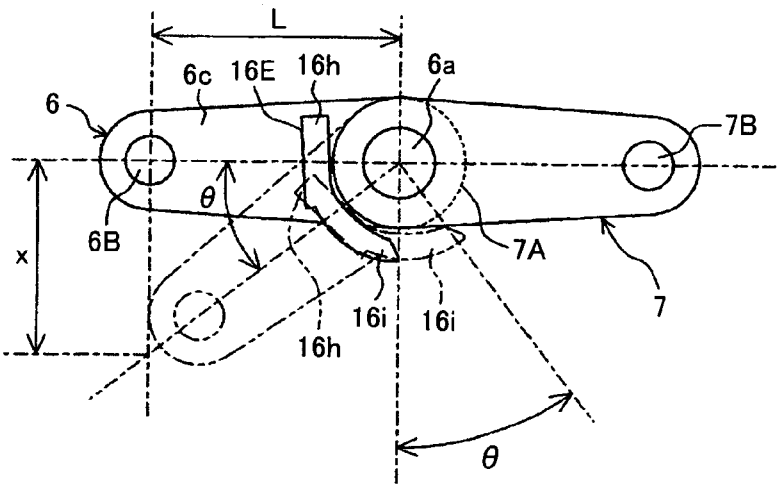

L
6c
16E
16h
6a
6
7B
θ
6B
x
7A
7
16i
16i
16h
θ

FIG. 15

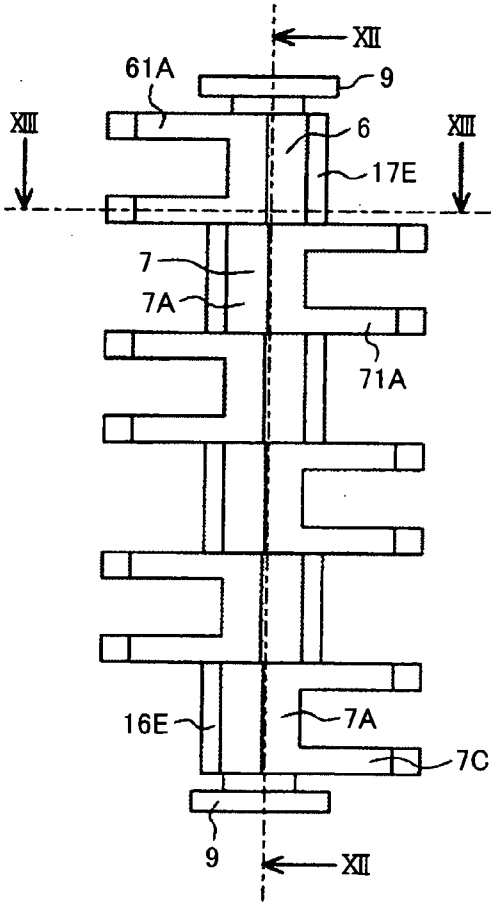

XII
61A
9
XIII
6
XIII
17E
7
7A
71A
16E
7A
7C
9
XII

FIG. 16

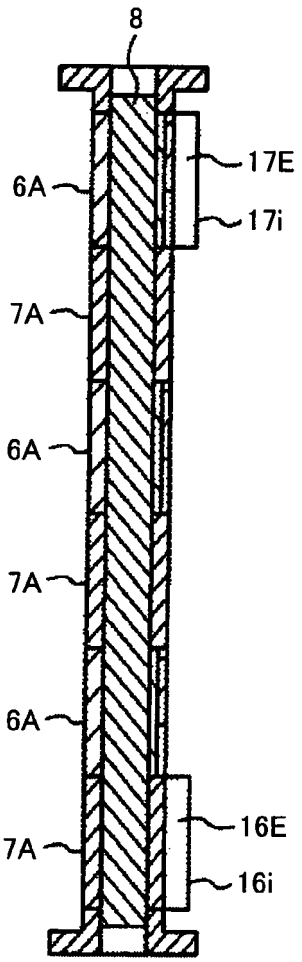

8
17E
6A
17i
7A
6A
7A
6A
16E
7A
16i

FIG. 17

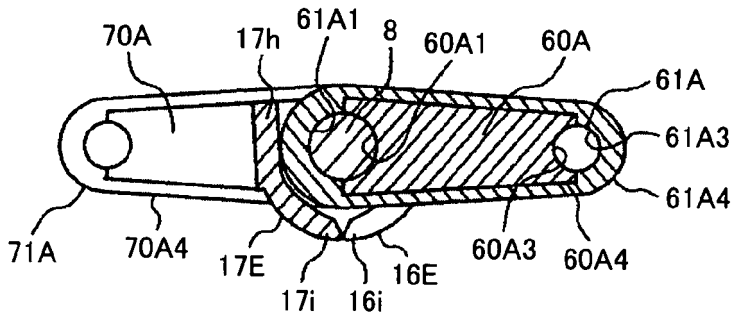

70A
17h
61A1
8
60A1
60A
61A
61A3
61A4
71A
70A4
17E
17i
16i
16E
60A3
60A4

FIG. 18A

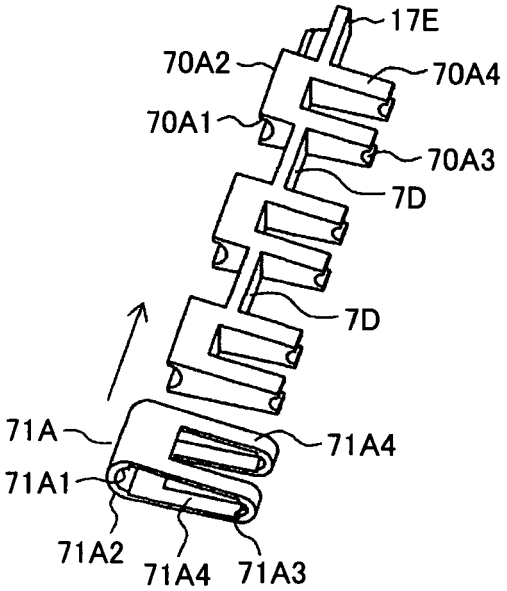


FIG. 18B

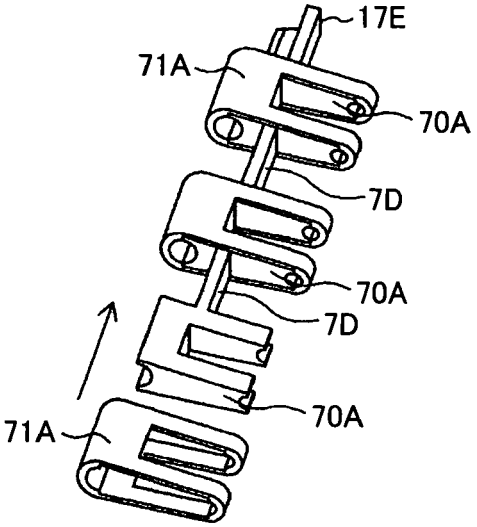
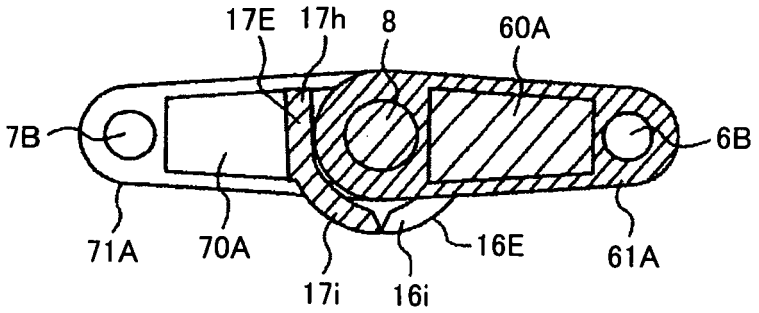


FIG. 19



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EUROPEAN SEARCH REPORT

Application Number
EP 09 00 9513

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
D,A	EP 1 628 315 A (HITACHI LTD [JP]) 22 February 2006 (2006-02-22) * figures 1,3,4 * -----	1	INV. H01H33/66
A	EP 1 909 302 A (ABB S P A [IT]) 9 April 2008 (2008-04-09) * paragraphs [0051] - [0060]; figures 5,6 * -----	1	
A	US 3 594 524 A (HEINTZ MILTON LOUIS) 20 July 1971 (1971-07-20) * column 1, lines 34-61; figures * -----	1	
A	EP 1 619 708 A (HITACHI LTD [JP]) 25 January 2006 (2006-01-25) * abstract; figure 3A * -----	1	
			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	23 October 2009	Findeli, Luc

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1

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23-10-2009

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- JP 2006059557 A **[0004]**