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(54) **CONTACT MECHANISM**

(57) In a contact mechanism (50) including a stationary contact (52) provided on a stationary contact terminal (51) and a movable contact (56) provided on a movable contact plate (60), the stationary contact (52) and the movable contact (56) being opposed to enable approach/separation, at least a pair of a first electromagnetic iron plate (90) and a second electromagnetic iron plate (91) disposed to oppose both ends are provided opposite to the stationary contact terminal (51) and the movable contact plate (60), respectively. An electric path passing through the stationary contact terminal (51) and the movable contact plate (60) through the first electro-

magnetic iron plate (90) and the second electromagnetic ironplate (91) is provided with insulating means for preventing both ends of the first electromagnetic iron plate (90) and the second electromagnetic iron plate (91) from being mutually sucked and the stationary contact terminal (51) and the movable contact terminal (54) from being conducted through the first electromagnetic iron plate (90) and the second electromagnetic iron plate (91) when the stationary contact (52) and the movable contact (56) come in contact with each other so that the stationary contact terminal (51) and the movable contact terminal (54) are set into a conducting state.

Fig.6A

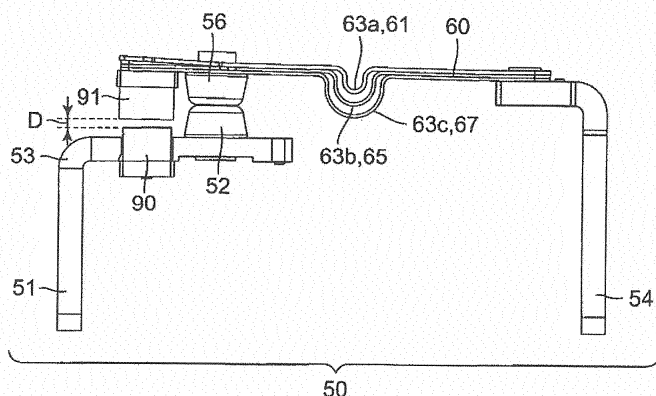
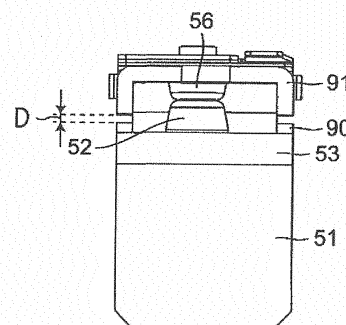


Fig.6B



Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a contact mechanism and, more particularly, to a contact mechanism incorporated in a switching device such as an electromagnetic relay.

BACKGROUND

10 **[0002]** Conventionally, there is disclosed a contact mechanism incorporated in a switching device such as an electromagnetic relay, which is disclosed and illustrated in Fig. 1 of Patent Document 1, for example. In the contact mechanism, a movable contact terminal 2 and a movable contact plate 4 are positioned to oppose to each other. Also, a contact button 6 of the movable contact plate 4 is configured so that, when a voltage is applied to the relay, the button 6 is moved away from a contact button 3 of a stationary contact terminal to cause a repelling force which is used for preventing a
15 disconnection between contacts.

PATENT DOCUMENT

[0003] Patent Document 1: US Patent No. 6, 661, 319

20 **[0004]** In this contact mechanism, however, the repelling force is unlikely to be well controlled, which can result in an unwanted disconnection of the contacts. Also, the opposed arrangement of the movable contact terminal 2 and the movable contact plate 4 may result in an enlargement of the movable contact terminal 2 which consumes a greater material for its production. This may result in an inefficient utilization of a space in the electromagnetic relay and also an increase the cost for producing it.

25 **[0005]** To overcome the problems, an object of the present invention to provide a contact mechanism which has an enhanced contact reliability and space utilization and is economically produced.

SUMMARY OF THE INVENTION

30 **[0006]** For this purpose, the contact mechanism according to the present invention comprises a stationary contact provided on a stationary contact terminal, and a movable contact provided on a movable contact plate, the stationary contact and the movable contact being opposed to enable approach/separation, and at least a pair of auxiliary attracting means disposed to oppose both ends is provided opposite to the stationary contact terminal and the movable contact plate, and an electric path passing through the stationary contact terminal and the movable contact plate through the
35 pair of auxiliary attracting means is provided with insulating means for preventing the pair of auxiliary attracting means from being mutually attracted and the stationary contact terminal and a movable contact terminal from being conducted through the pair of auxiliary attracting means when the stationary contact and the movable contact come in contact with each other so that the stationary contact terminal and the movable contact terminal are set into a conducting state.

40 **[0007]** According to the present invention, a magnetic flux is generated in the pair of auxiliary attracting means and a attraction force is generated between the auxiliary attracting means in an operation. For this reason, it is possible to increase a contact force between the stationary contact and the movable contact without disposing the movable contact terminal and the movable contact plate opposite to each other as in the related art. Therefore, it is possible to improve contact reliability, furthermore, to reduce the movable contact terminal, thereby enhancing a space efficiency.

45 **[0008]** As an embodiment of the present invention, it is also possible to have a structure in which the insulating means is provided in at least one place between the stationary contact terminal and the auxiliary attracting means of the stationary contact terminal, between the movable contact plate and the auxiliary attracting means of the movable contact plate or in opposed portions of the pair of auxiliary attracting means.

[0009] According to the present embodiment, the pair of auxiliary attracting means can be insulated effectively from each other. Therefore, it is possible to ensure a stable attraction force between the auxiliary attracting means.

50 **[0010]** As the embodiment of the present invention, it is also possible to have a structure in which a clearance is formed between the both ends opposed in the pair of auxiliary attracting means when the stationary contact and the movable contact come in contact with each other.

[0011] According to the present embodiment, the clearance is provided between the auxiliary attracting means. Therefore, heat is not generated in the operation. Therefore, the movable contact plate can be formed thinly so that a manufacturing cost can be reduced.

55 **[0012]** As the embodiment of the present invention, it is also possible to have a structure in which an interval of the clearance is equal to or smaller than 0.5 mm.

[0013] According to the present embodiment, it is possible to improve contact reliability and to reduce a size of the

movable contact terminal, thereby enhancing a space efficiency.

[0014] As the embodiment of the present invention, it is also possible to have a structure in which the auxiliary attracting means is disposed on a free end of the movable contact plate.

[0015] According to the present embodiment, it is possible to obtain a great contact force with a small attraction force.

[0016] As the embodiment of the present invention, it is also possible to have a structure in which the auxiliary attracting means is disposed in a non-conducting portion of the movable contact plate.

[0017] According to the present embodiment, it is possible to obtain a great contact force with a small attraction force.

[0018] As the embodiment of the present invention, it is also possible to have a structure in which plural pairs of the auxiliary attracting means are provided.

[0019] According to the present embodiment, the attraction force between the stationary contact and the movable contact is further increased. Therefore, it is possible to obtain a contact mechanism having high contact reliability.

[0020] As another embodiment of the present invention, it is also possible to have a structure in which the pair of auxiliary attracting means has the same external shape.

[0021] According to the present embodiment, a degree of freedom of a design can be increased so that the design can easily be carried out.

[0022] As a further embodiment of the present invention, it is also possible to have a structure in which the pair of auxiliary attracting means has external shapes which are different from each other.

[0023] According to the present embodiment, a degree of freedom of a design can be increased so that the design can easily be carried out.

[0024] Moreover, the electromagnetic relay according to the present invention is characterized by the auxiliary attracting means.

[0025] According to the present invention, it is possible to obtain an electromagnetic relay including a contact mechanism having high contact reliability, a high space efficiency and a small manufacturing cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026]

Fig. 1A is a general perspective view showing an electromagnetic relay to which a contact mechanism according to an embodiment of the present invention is applied and Fig. 1B is a perspective view showing a state in which a cover of the electromagnetic relay in Fig. 1A is removed.

Figs. 2A and 2B are plan views showing states brought before and after an operation.

Fig. 3 is an exploded perspective view showing the electromagnetic relay in Fig. 1A.

Fig. 4 is an exploded perspective view seen at a different angle from that in Fig. 3.

Fig. 5 is an exploded perspective view showing a main part of the electromagnetic relay in Fig. 1B.

Figs. 6A and 6B are a front view and a side view showing a contact mechanism illustrated in Fig. 3.

Fig. 7 is a front view and a sectional view showing a relationship between a direction of a current, and a magnetic field and a attraction force in conduction of the contact mechanism.

Fig. 8 is a perspective view showing auxiliary attracting means of a contact mechanism according to another embodiment of the present invention.

Fig. 9 is a perspective view showing auxiliary attracting means of a contact mechanism according to a further embodiment of the present invention.

Fig. 10 is a perspective view showing auxiliary attracting means of a contact mechanism according to a further embodiment of the present invention.

Fig. 11 is a perspective view showing auxiliary attracting means of a contact mechanism according to a further embodiment of the present invention.

Fig. 12 is a perspective view showing auxiliary attracting means of a contact mechanism according to a further embodiment of the present invention.

Fig. 13 is a perspective view showing auxiliary attracting means of a contact mechanism according to a further embodiment of the present invention.

Fig. 14 is a perspective view showing auxiliary attracting means of a contact mechanism according to a further embodiment of the present invention.

Fig. 15 is a perspective view showing auxiliary attracting means of a contact mechanism according to a further embodiment of the present invention.

EMBODIMENTS OF THE INVENTION

[0027] Referring to the accompanying drawings, several embodiments of an electromagnetic relay including a contact

mechanism according to the invention will be described in detail hereinafter.

[0028] An exemplified embodiment of the electromagnetic relay, which is a self-holding type electromagnetic relay, has a box-shaped base 10, an electromagnet block 20, a rotating block 30, a contact mechanism 50, a support plate 70, and a cover 80.

[0029] As shown in Fig. 2, the box-like base 10 has a first receiving portion 12 for receiving the electromagnet block 20, a second receiving portion 13 for receiving the contact mechanism 50, and an insulating wall 11 provided between the first receiving portion 12 and the second receiving portion 13. The insulating wall 11 is formed to extend perpendicularly from a side surface 10A of the base 10 to a position which corresponds to a central portion of another side surface 10B. A driving arm 35 of the rotating block 30, which will be described below, is positioned at the opening formed in front of the insulating wall 11 between the first receiving portion 12 and the second receiving portion 13. As shown in Fig. 1, the base 10 has shallow recesses or grooves 14a formed vertically in respective outer surfaces thereof and projected engaging portions 14b formed on respective bottom surfaces of the shallow grooves 14a.

[0030] As shown in Fig. 3, the side wall 10C of the base 10 has a terminal receiving slot 15c formed in one end portion thereof (upper-right side portion in Figs. 2A and 2B) for receiving a pair of coil terminals 29 of the electromagnet block 20. As shown in Fig. 4, the side surface 10B of the base 10 has terminal receiving slots 15a and 15b formed on opposite ends thereof for receiving stationary and movable contact terminals 51 and 54, respectively.

[0031] As shown in Fig. 5, the electromagnet block 20 has a spool 21 with opposite flanges 22a and 22b formed therewith, an iron core 24 inserted in a through-hole 22c defined in the spool 21, a coil 23 wound around the spool 21, and yokes 25 and 27 fixed at opposite ends of the iron core 24 projected from the spool 21. The yokes 25 and 27 are made of substantially L-shaped magnetic plate and have transversely-extended wide portions 26 and 28, respectively. The flange 22a of the spool 21 has terminal holes defined therein. A pair of coil terminals 29 are press-fitted in the terminal holes. The opposite ends of the coil 23 are wound around the coil terminals 29 and soldered thereto. The electromagnet block 20 is press-fitted in the base 10 with the wide portions 26 and 28 engaged in the positioning recesses (not shown) and thereby fixed in place in the base 10. As such, the arrangement of the wide portions 26 and 28 can minimize a possible displacement of the electromagnet block 20 relative to the rotating block 30 described below. The upward and downward extending arrangement of the wide portions 26 and 28 allows a single component to be commonly used for the yokes, which reduces a manufacturing cost of the electromagnetic relay.

[0032] The coil terminal 29 does not need to be a simple bar-like member, and it may be substantially a T-shaped member, for example.

[0033] As shown in Figs. 3 and 5, the rotating block 30 has a rotating block body 33 and the driving arm 35.

[0034] The rotating block body 33 has a permanent magnet (not shown) and a pair of plate-like movable iron plates 31 and 32 holding the permanent magnet therebetween, both integrally insert-molded in the rotating block body 33. The rotating block body 33 also has rotating shafts 34a and 34b aligned coaxially and projected from the upper and lower surfaces thereof and a driving arm 35 integrally molded on the side surface of the rotating block body 33. As shown in Fig. 3, the driving arm 35 is extended outward along the movable iron plate 32. Also, as shown in Fig. 4, the driving arm 35 has a bent nail 36 formed at a distal end thereof.

[0035] As shown in Figs. 5 and 6, the contact mechanism 50 has the stationary contact terminal 51 and the movable contact terminal 54. The movable contact terminal 54 has a movable contact plate 60.

[0036] The stationary contact terminal 51, which is substantially L-shaped, has a stationary contact 52 fixed on one end thereof. Also, the stationary contact terminal 51 has an auxiliary attracting means or first electromagnetic iron plate 90 mounted on an electrically conducting portion thereof between the stationary contact 52 and the bent portion 53. The stationary contact terminal 51 has cutouts 55 formed on its longitudinal edges for engagement with the electromagnetic iron plate 90.

[0037] The first electromagnetic iron plate 90, which has a square-bracket cross section, has a planar portion 90a and projecting portions 90b projecting from the opposite ends of the planar portion 90a in the same direction. The planar portion 90a and the projecting portions 90b have the same transverse width. The first electromagnetic iron plate 90 is fixed to the stationary contact terminal 51 with the projecting portions 90b engaged with and projected through the cutouts 55 and 55.

[0038] The movable contact terminal 54 has an L-shaped cross section which is bent at a position different from that in the stationary contact terminal 51. The movable contact terminal 54 supports the movable contact plate 60 fixed to one end thereof. The movable contact plate 60, which is made of three - first, second, and third-conductive thin plate springs 61, 65, and 67 stacked in this order, supports a movable contact 56 and an auxiliary attracting means or second electromagnetic iron plate 91 fixed at distal end thereof. When the movable and stationary contacts 56 and 52 are in contact with each other, the movable and stationary contact terminals 54 and 51 are electrically connected through the movable and stationary contacts 56 and 52 but, in this condition, no electricity flows in the distal end portion of the movable contact plate 60. This means that the second electromagnetic iron plate 91 is mounted in a non-electrically conducting portion of the movable contact plate 60.

[0039] The first conductive thin plate spring 61 has a spring coefficient adjusting slit 62a formed therein to extend in

a proximal to distal direction and a substantially U-shaped fold 63a formed at a mid-portion thereof for accommodating and relieving expansion and contraction thereof caused in the movement of the spring and thereby ensuring a smooth movement of the spring. The first conductive thin plate spring 61 is divided into two transversely neighboring prongs-driving elastic tongue 64a and remaining divided piece 64b. The divided piece 64b supports the movable contact 56 and the second electromagnetic iron plate 91 fixed thereto.

[0040] The second conductive thin plate spring 65 has a spring coefficient adjusting slit 62b formed therein to extend in a proximal to distal direction and a substantially U-shaped fold 63a formed at a mid-portion thereof for accommodating and relieving expansion and contraction thereof caused in the movement of the spring and thereby ensuring a smooth movement of the spring. The second conductive thin plate spring 65 has a cutout 66a formed at one distal end corner opposing the driving elastic tongue 64a of the first conductive thin plate spring 61 to define an attaching piece 66b. The attaching piece 66b supports the movable contact 56 and the second electromagnetic iron plate 91 fixed thereto.

[0041] The third conductive thin plate spring 67 has a substantially U-shaped fold 63c formed at a mid-portion thereof for accommodating and relieving expansion and contraction thereof caused in the movement of the spring and thereby ensuring a smooth movement of the spring.

[0042] The spring coefficient of the first and second conductive thin plate springs 61 and 65 may be controlled as necessary by adjusting the width and/or length of the slits 62a and 62b, respectively. This facilitates the adjustment of the spring load caused in the connecting and disconnecting operations, and increases design flexibility.

[0043] The second electromagnetic iron plate 91, which is in the form of square-bracket as electromagnetic iron plate 90, has a planar portion 91a and projecting portions 91b projecting from the opposite ends of the planar portion 91a in the same direction. The second electromagnetic iron plate 91 is held on the distal end of the movable contact plate 60 by fixing the planar portion 91a to the movable contact plate 60, with the projecting portions 91b projected toward the stationary contact terminal 51. In this embodiment, the first and the second electromagnetic iron plates 90 and 91 have substantially the same outer configuration.

[0044] As shown in Fig. 3, the support plate 70, which is made of a substantially S-shaped plate, has a bearing hole 71 formed at a mid-portion thereof, for receiving a rotating shaft 34b of the rotating block 30 engaged therein. The support plate 70 also has a fitting hole 72 and a fitting projection 73 formed at opposite ends thereof for fixing it to the base 10. Therefore, the engaging projection 16 of the base 10 is fitted in the fitting hole 72, and the fitting projection 73 of the support plate 70 is fitted in the fitting hole 17 of the base 10, which ensures a precise assembling and positioning of the rotating block 30.

[0045] The cover 80 has a rectangular configuration which covers the opening of the base 10 and has elastic engaging portions 81 extending downward from respective peripheral edges.

[0046] Descriptions will now be made to an operation of the electromagnetic relay so constructed.

[0047] As shown in Fig. 2A, when de-energized, the electromagnetic relay takes the original position in which one end 31b of the movable iron plate 31 of the rotating block 30 is attracted to the yoke 25 and the other end 32a of the movable iron plate 32 is attracted to the yoke 27 by a magnetic force of a permanent magnet (not shown). In this condition, the distal end of the driving arm 35 of the rotating block 30 is positioned between the projecting portions 91b of the second electromagnetic iron plate 91 to raise the movable contact plate 60, which causes the movable contact 56 is kept away from the stationary contact 52.

[0048] When a voltage is applied to the coil to generate a magnetic force which overcomes the magnetic force of the permanent magnet in the electromagnet block 20, one end 31a of the movable iron plate 31 of the rotating block 30 is attracted to the yoke 27 and the other end 32b of the movable iron plate 32 of the rotating block 30 is attracted to the yoke 25, which rotates the rotating block 30. The rotation of the rotating block 30 causes the driving arm 35 of the rotating block 30 to force the movable contact plate 60 downward. This results in an elastic deformation of the forced movable contact plate 60, causing the movable contact 56 to make into contact with the stationary contact 52. Then, the other end 32b of the movable iron plate 32 of the rotating block 30 is attracted to the yoke 25, and the end 31a of the movable iron plate 31 is attracted to the yoke 27 (Fig. 2B).

[0049] When the electromagnetic relay is in operation, the movable and stationary contacts 56 and 52 are connected to each other. This allows an electric current to flow between the stationary and movable contact terminals 51 and 54, causing a magnetic field which extends through the first and second electromagnetic iron plates 90 and 91. The generated magnetic field causes an attraction force F between the first and second electromagnetic iron plates 90 and 91 to prevent the connection between the movable and stationary contacts 56 and 52 from being broken by electromagnetic repulsion which may occur at the application of electric current. Because a gap D exists between the first and second electromagnetic iron plates 90 and 91 (see Fig.6), no electric current flows therebetween. This prevents the first and second electromagnetic iron plates 90 and 91 from heating, allowing the movable contact plate 60 to have a smaller thickness and to be manufactured economically.

[0050] The gap D between the first and second electromagnetic iron plates 90 and 91 may be replaced by any insulating means or member. For example, the insulating means may be provided in a portion between the first electromagnetic iron plate 90 and the stationary contact terminal 51 and/or in a portion between the second electromagnetic iron plate

91 and the movable contact plate 60, in each of which no electric current flows between the stationary and movable contact terminals 51 and 54 through the first and second electromagnetic iron plates 90 and 91.

[0051] The insulating member may be made from molding material such as PBT (polybutylene terephthalate) and LCP (liquid crystal polymer) or insulating material such as rubber. The insulating member may be made from the same material as the base 10. An insulating layer may be made by plating an insulating film on the electromagnetic iron plates.

[0052] When a voltage is applied to the coil 23 in an opposite direction, the driving arm 35 is forced in a direction away from the movable contact terminal 54 by the spring force of the movable contact plate 60. Then, one end 31b of the movable iron plate 31 of the rotating block 30 is attracted to the yoke 25 and the other end 32a of the movable iron plate 32 is attracted to the yoke 27 by the magnetic force of the permanent magnet, which rotates the rotating block 30 into the original position shown in Fig. 2A.

[0053] The attraction force F generated between the first and second electromagnetic iron plates 90 and 91 always exists irrespective of the flowing direction of the electric current. Namely, the magnetic field is constantly generated in the first and second electromagnetic iron plates 90 and 91 to cause the attraction force F between the first and second electromagnetic iron plates 90 and 91 irrespective of whether the electric current flows from the movable contact terminal 54 to the stationary contact terminal 51 or vice versa.

[0054] When the electromagnetic relay is in operation, the magnetic flux is generated in the first and second electromagnetic iron plates 90 and 91 to cause the attraction force therebetween. This increases a contact force between the stationary contact 52 and the movable contact 56 to result in a reliable contact therebetween irrespective of whether the movable contact terminal 54 and the movable contact plate 60 oppose to each other. Also, this also results in a miniaturization of the contact mechanism 50 and an effective utilization of space in the electromagnetic relay.

[0055] According to the described electromagnetic relay, the movable contact plate 60 does not interfere with the driving arm 35 of the rotating block 30, which facilitates the assembling of and increases the productivity of the electromagnetic relay.

[0056] Because the first electromagnetic iron plate 90 is positioned in a passage where the electric current flows toward the stationary contact 52 and the second electromagnetic iron plate 91 is positioned at a distal end portion of the movable contact plate 60 where no electric current flows, an enhanced contact force is obtained with less attraction force. The positions of the first and second electromagnetic iron plate 90 and 91 are not limited thereto. For example, the first electromagnetic iron plate 90 may be provided in the portion of the stationary contact terminal 51 where no electric current flows, and the second electromagnetic iron plate 91 may be provided at a distal end portion of the movable contact plate 60 of the movable contact terminal 54 where the electric current flows, in each of which an enhanced contact force is obtained. The stationary contact 52 and the first electromagnetic iron plate 90, and the movable contact 56 and the second electromagnetic iron plate 91 may be positioned on the same line running in the transverse direction.

[0057] Although the second electromagnetic iron plate 91 is fixed to the movable contact plate 60, this is not restrictive to the invention and the second electromagnetic iron plate 91 may be soldered to the movable contact plate 60, for example. The soldering is more advantageous than the mechanical fixing in increasing the assembling precision. Also, the first electromagnetic iron plate 90 may be integrally formed in the stationary contact 52, and the second electromagnetic iron plate 91 may be integrally formed in the movable contact plate 60. In this instance, the number of components can be reduced.

[0058] Although the contact surfaces of the stationary contact 52 and the movable contact 56 are outwardly curved in this embodiment, this is not restrictive and they may be a flat, tapered or spherical surface.

[0059] Although both the first and second electromagnetic iron plates 90 and 91 of the contact mechanism 50 have a substantially square-bracket cross section in this embodiment, this is not restrictive. For example, as shown in Fig. 8A, the first electromagnetic iron plate 190 may have an L-shaped cross section. Also, as shown in Fig. 8B, one the first electromagnetic iron plate 290 may have a square bracket cross section in which one of two projections has a different size than the other. Further, as shown in Fig. 8C, the second electromagnetic plate 391 may have a plate configuration. Moreover, as shown in Fig. 8D, the first electromagnetic plate 490 may have a plate configuration.

[0060] Although the contact mechanism 50 of this embodiment uses the first and second electromagnetic iron plates 90 and 91 in which the distal end surface of the projecting portions 90b and 91b are made of flat surfaces as shown in Fig. 9, the invention is not limited thereto. For example, as shown in Fig. 10, first and second electromagnetic iron plates 490 and 491 may be used in which the distal end surfaces of the projections have concave portions formed thereon. Also, as shown in Fig. 11, first and second electromagnetic iron plates 590 and 591 may be used in which three concave portions are formed therein. Further, as shown in Fig. 12, first and second electromagnetic iron plates 690 and 691 may be used in which the distal end surfaces of the projections have three concave portions and the remaining convex portions with distal ends thereof rounded. Further, as shown in Fig. 13, first and second electromagnetic iron plates 790 and 791 may be used in which the distal end surfaces of the projections are in the form of tapered triangles. Furthermore, as shown in Fig. 14, first and second electromagnetic iron plates 890 and 891 may be used in which the distal end surfaces of the projections are rounded in arc. Moreover, as shown in Fig. 15, first and second electromagnetic iron plates 990 and 991 may be used in which the distal end surfaces of the projections have three concave portions and

the remaining convex portions with distal ends thereof chamfered.

[0061] By using any one of those electromagnetic iron plates, the contact force and the wiping effect are increased.

[0062] The electromagnetic iron plate in Fig. 8 may be combined with any one of other electromagnetic iron plates shown in Figs. 9-15.

[0063] By taking any distal end configuration of the projecting portion in the electromagnetic iron plate as described above, a desired attraction force may be obtained between the electromagnetic iron plates.

[0064] Although the pair of first and second electromagnetic iron plates 90 and 91 are provided in the contact mechanism 50 in the previous embodiment, the present invention is not restricted thereto and a plurality pairs of electromagnetic iron plates may be provided in which, because an increased attraction force is obtained between the stationary and movable contacts 52 and 56, a high contact reliability is obtained in the contact mechanism.

EXAMPLE(S)

[0065] Next, description will be made to a relationship between the distance D (the air gap) between the electromagnetic iron plates of the stationary and movable contact terminals 51 and 54 and the attraction force F acting between the electromagnetic iron plates of the stationary and movable contact terminals 51 and 54. More specifically, the gap D was varied to measure the attraction force F between the electromagnetic iron plates in the contact mechanism 50 in its operation. A ratio of the measured attraction forces F to the spring force of the movable contact plate 60 was obtained to examine the relationship between the gap D and the attraction force F.

Structure:

[0066] The electromagnetic relay according to the embodiment was used. The first electromagnetic iron plate 90 and the second electromagnetic iron plate 191 having the patterns shown in Fig. 8(c) were used as the electromagnetic iron plates.

Stationary and Movable Contact Terminals:

[0067] The stationary contact terminal 51 and the movable contact terminal 54 having a width of 10 mm were used.

Electromagnetic Iron Plate:

[0068] An iron plate with the planar portion 90a having a width of 3 mm, a length of 12 mm, and a thickness of 1 mm and the projecting portion 90b having a width of 3 mm, a length of 3 mm, and a thickness of 1 mm was used for the first electromagnetic iron plate 90 (square bracket shaped iron plate). An iron plate having a width of 3 mm, a length of 12 mm, and a thickness of 1 mm was used for the second electromagnetic iron plate 191 (plate-shaped iron plate).

Current:

[0069] A current having a magnitude of 2.5 kArms was applied to flow from the movable contact terminal 54 to the stationary contact terminal 51.

Attraction force F:

[0070] From the above conditions, the attraction force F was obtained in accordance with the following equations. Table 1 shows a result of the calculation. In the following equations, μ_0 represents a space permeability, S represents an area of an absorbing portion of an electromagnetic iron plate, N represents the number of coil turns, I represents a current, and μ represents a magnetic permeability of an electromagnetic iron plate. Suction force :

$$F = \frac{\phi^2}{2\mu_0 S}$$

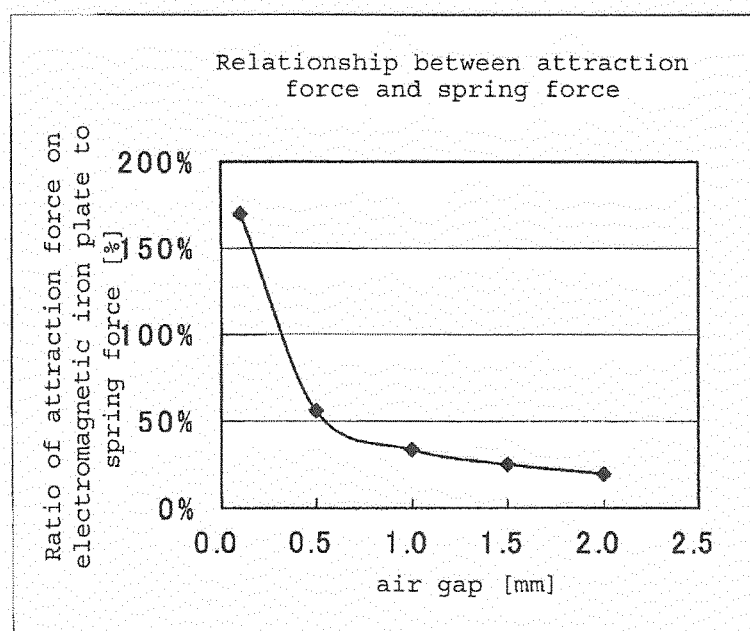
Magnetic flux:

$$\phi = \frac{NI}{R}$$

Magnetic resistance :

$$R = \frac{l}{\mu A}$$

[Table 1]



[0071] As shown in the Table 1, the attraction force F is 20 % when the air gap is 2.0 mm, the attraction force F is 25 % when the air gap is 1.5 mm, the attraction force F is 34 % when the air gap is 1.0 mm, the attraction force F is 56 % when the air gap is 0.5 mm, and the attraction force F is 170 % when the air gap is 0.1 mm. In other words, when the gap D between the electromagnetic iron plates is reduced, the attraction force F acting between the electromagnetic iron plates is increased. When the gap D between the electromagnetic iron plates is increased excessively, the attraction force is reduced and the size of the electromagnetic relay is increased. Accordingly, the result shows that the gap D between the electromagnetic iron plates is preferably greater than 0 and equal to or smaller than 0.5 mm.

[0072] The movable contact plate and the contact mechanism according to the present invention are not restricted to be used in the electromagnetic relay described above, but they may be used in another electromagnetic relays.

DESCRIPTION OF REFERENCE SYMBOLS

[0073]

10	BOX-SHAPED BASE
10A, 10B, 10C	SIDE SURFACE
11	INSULATING WALL
12	FIRST RECEIVING PORTION
13	SECOND RECEIVING PORTION
14a	SHALLOW GROOVE
14b	ENGAGING PORTION
15a, 15b, 15c T	ERMINAL RECEIVING SLOT

16	FITTING PROJECTION
17	FITTING HOLE
20	ELECTROMAGNET BLOCK
21	SPOOL
5 22a, 22b	FLANGE
22c	THROUGH HOLE
23	COIL
24	IRON CORE
25, 27	YOKE
10 26, 28	WIDE PORTION
29	COIL TERMINAL
30	ROTATING BLOCK
31, 32	ROTATING IRON PLATE
33	ROTATING BLOCK BODY
15 34a, 34b	ROTATING SHAFT
35	DRIVING ARM
36	NAIL
50	CONTACT MECHANISM
51	STATIONARY CONTACT TERMINAL
20 52	STATIONARY CONTACT
53	BENT PORTION
54	MOVABLE CONTACT TERMINAL
55	CUTOUT
56	MOVABLE CONTACT
25 60	MOVABLE CONTACT PLATE
61	FIRST CONDUCTIVE THIN PLATE SPRING
62a, 62b	SPRING COEFFICIENT ADJUSTING SLIT
63a, 63b, 63c	FOLD
64	DRIVING ELASTIC TONGUE
30 65	SECOND CONDUCTIVE THIN PLATE SPRING
66	CUTOUT
67	THIRD CONDUCTIVE THIN PLATE SPRING
70	SUPPORT PLATE
71	BEARING HOLE
35 72	FIXING HOLE
73	FITTING PROJECTION
80	COVER
81	ELASTIC ENGAGING PORTION
90	FIRST ELECTROMAGNETIC IRON PLATE
40 90a, 91a	PLANAR PORTION
90b, 91b	PROJECTING PORTION
91	SECOND ELECTROMAGNETIC IRON PLATE

45 **Claims**

1. A contact mechanism portion comprising:

- a stationary contact provided on a stationary contact terminal; and
 50 a movable contact provided on a movable contact plate, the stationary contact and the movable contact being opposed to enable approach/separation, wherein
 at least a pair of auxiliary attraction means disposed to oppose both ends are provided opposite to the stationary contact terminal and the movable contact plate, respectively, and
 55 an electric path passing through the stationary contact terminal and the movable contact plate through the auxiliary attraction means is provided with insulating means for preventing the pair of auxiliary attraction means from being mutually attracted and the stationary contact terminal and a movable contact terminal from being conducted through the auxiliary attraction means when the stationary contact and the movable contact come

in contact with each other so that the stationary contact terminal and the movable contact terminal are set into a conducting state.

- 5 **2.** The contact mechanism portion according to claim 1, wherein the insulating means is provided in at least one place between the stationary contact terminal and the auxiliary attraction means of the stationary contact terminal, between the movable contact plate and the auxiliary attraction means of the movable contact plate or between the pair of auxiliary attraction means.
- 10 **3.** The contact mechanism portion according to claim 1 or 2, wherein when the stationary contact and the movable contact come in contact with each other, a clearance is formed between the both ends opposed in the pair of auxiliary attraction means.
- 15 **4.** The contact mechanism portion according to claim 3, wherein an interval of the clearance is equal to or smaller than 0.5 mm.
- 20 **5.** The contact mechanism portion according to any of claims 1 to 4, wherein the auxiliary attraction means is disposed in a conducting portion of the stationary contact terminal and a non-conducting portion of the movable contact plate or a non-conducting portion of the stationary contact terminal and a conducting portion of the movable contact plate.
- 25 **6.** The contact mechanism portion according to any of claims 1 to 4, wherein the auxiliary attraction means is disposed on a free end of the movable contact plate.
- 30 **7.** The contact mechanism portion according to any of claims 1 to 6, wherein a plurality of pairs of the auxiliary attraction means are provided.
- 8.** The contact mechanism portion according to any of claims 1 to 6, wherein the pair of auxiliary attraction means have the same external shape.
- 9.** The contact mechanism portion according to any of claims 1 to 6, wherein the pair of auxiliary attraction means have external shapes which are different from each other.
- 10.** An electromagnetic relay comprising the contact mechanism portion according to any of claims 1 to 9.

Fig. 1A

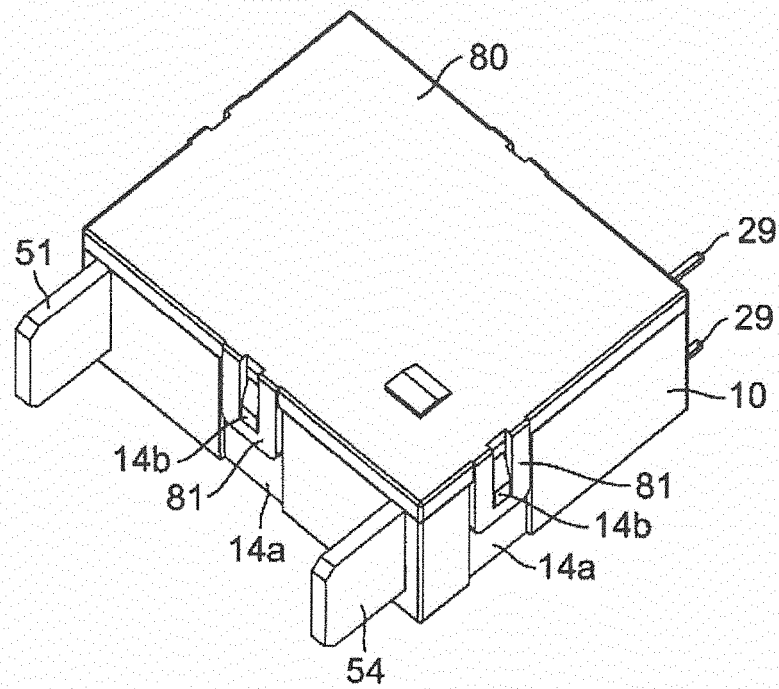


Fig. 1B

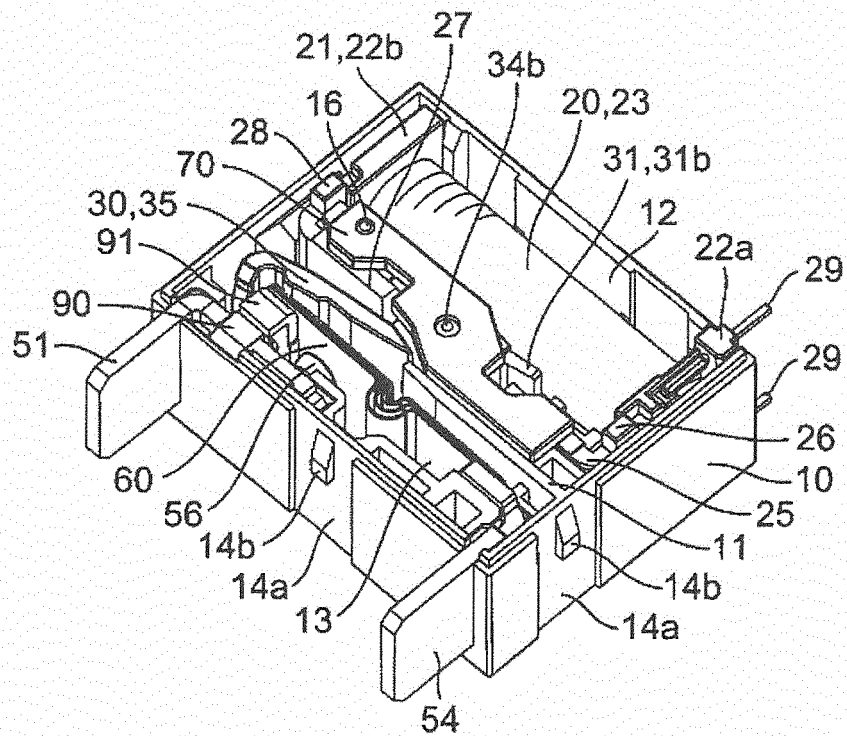


Fig. 2A

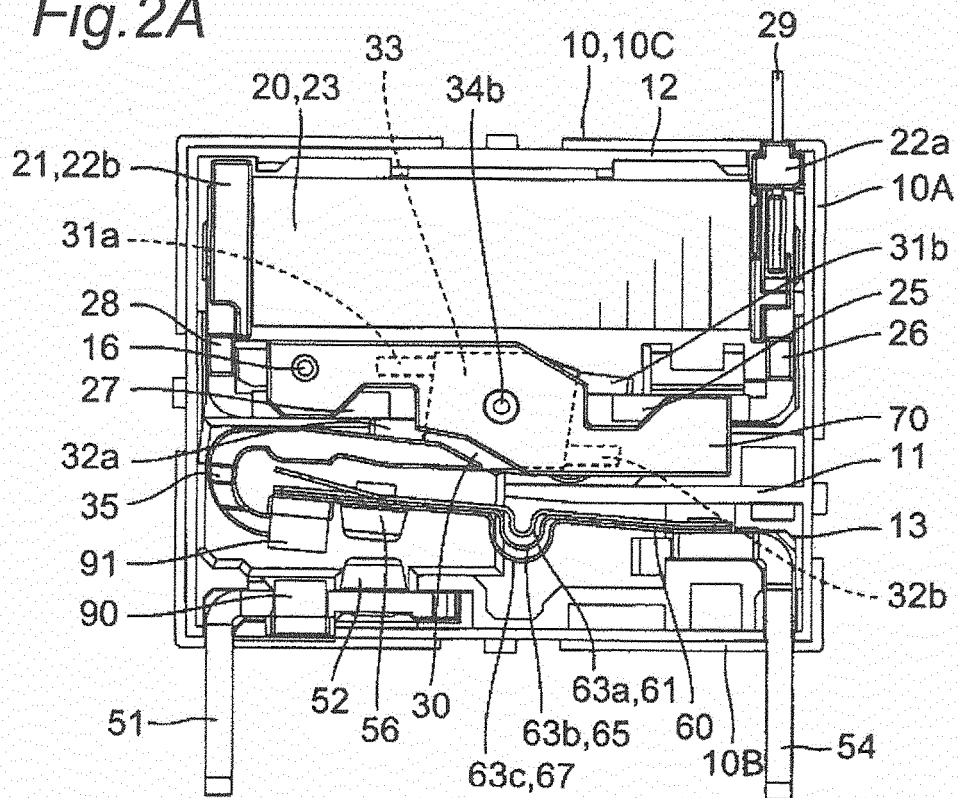


Fig. 2B

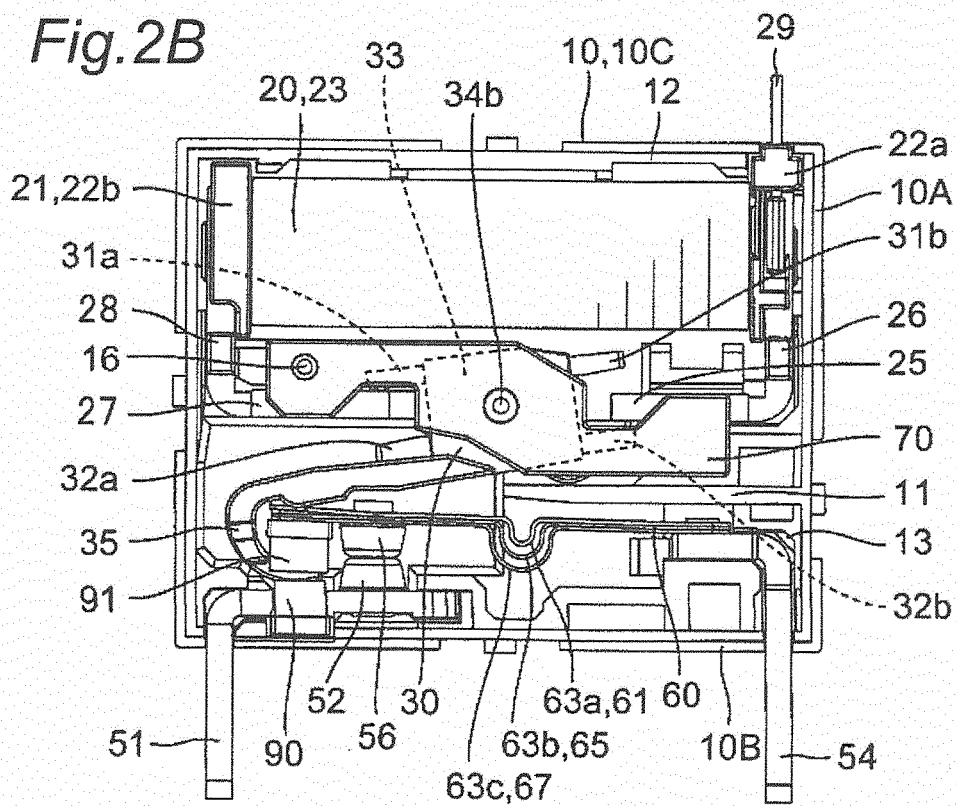


Fig.3

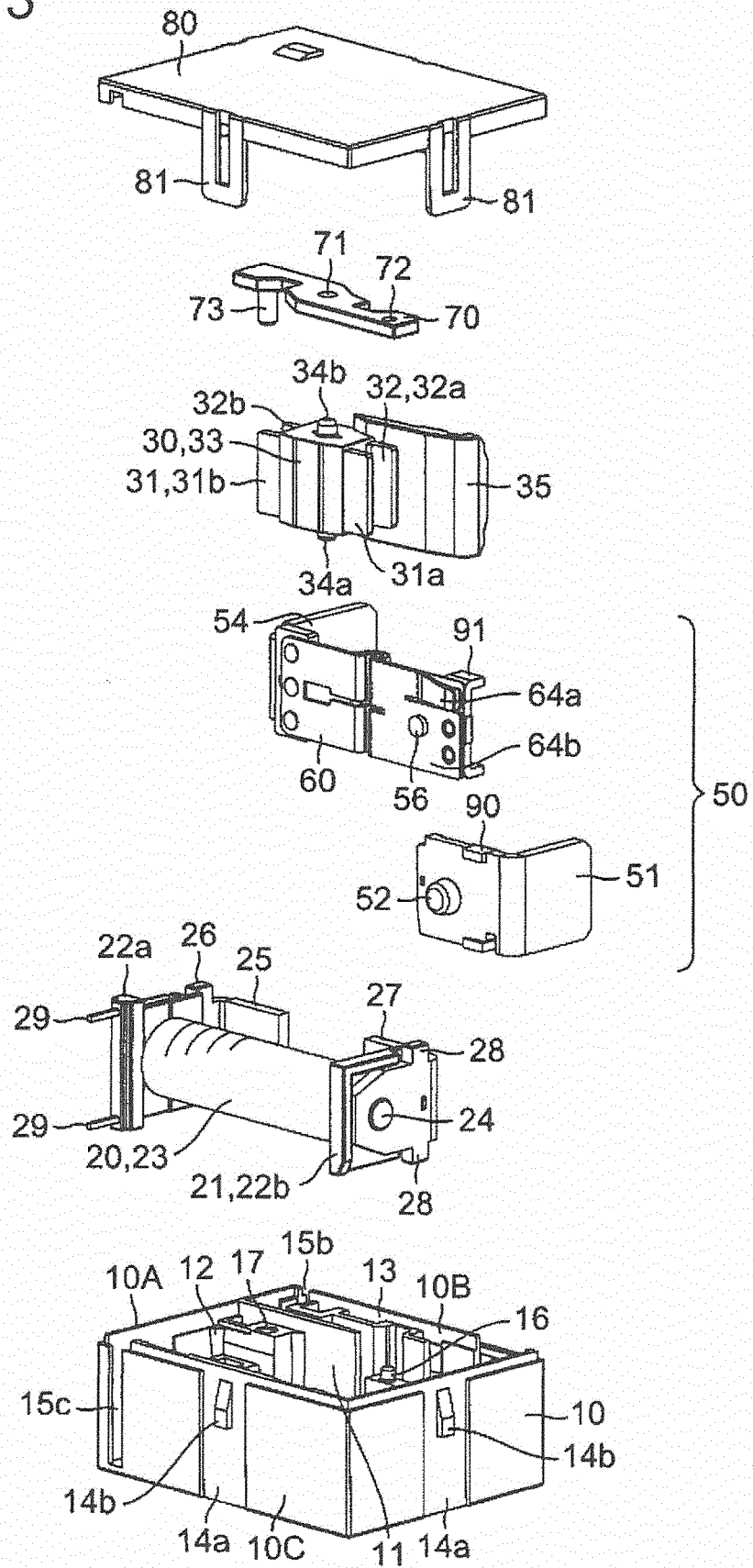


Fig. 4

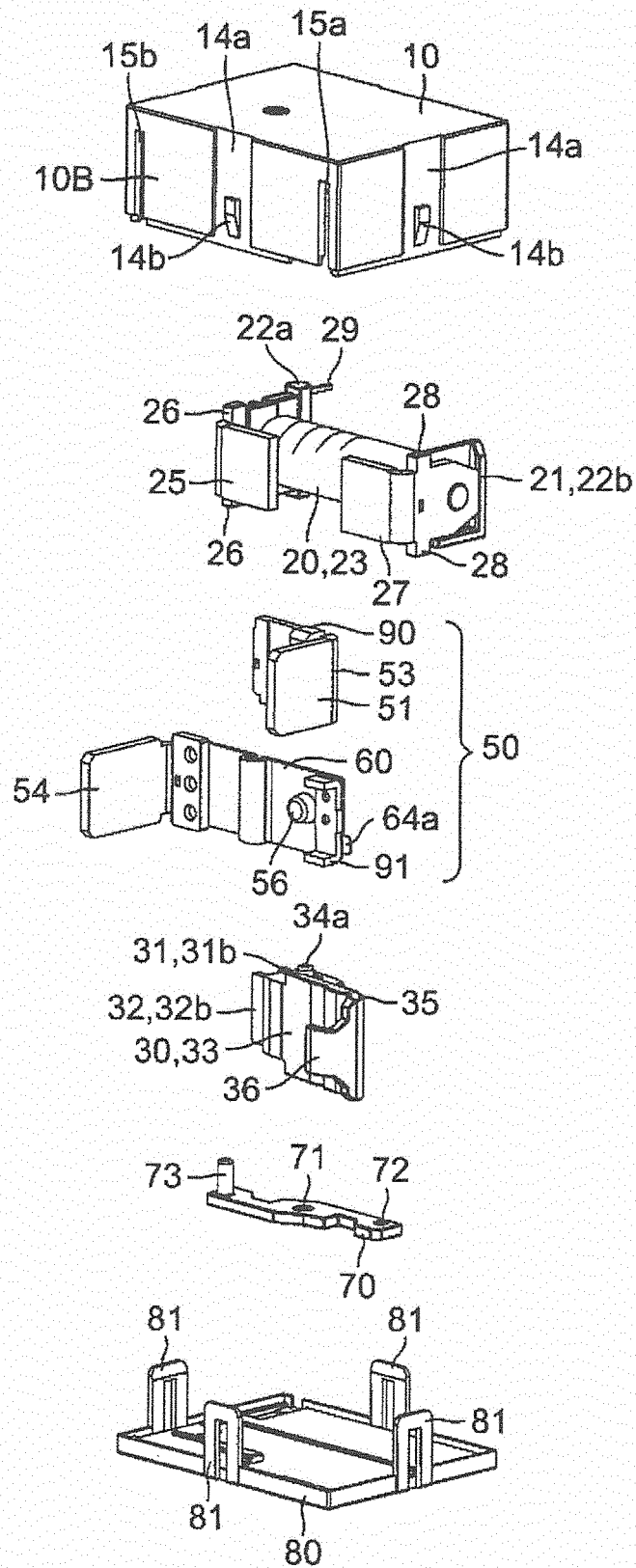


Fig. 5

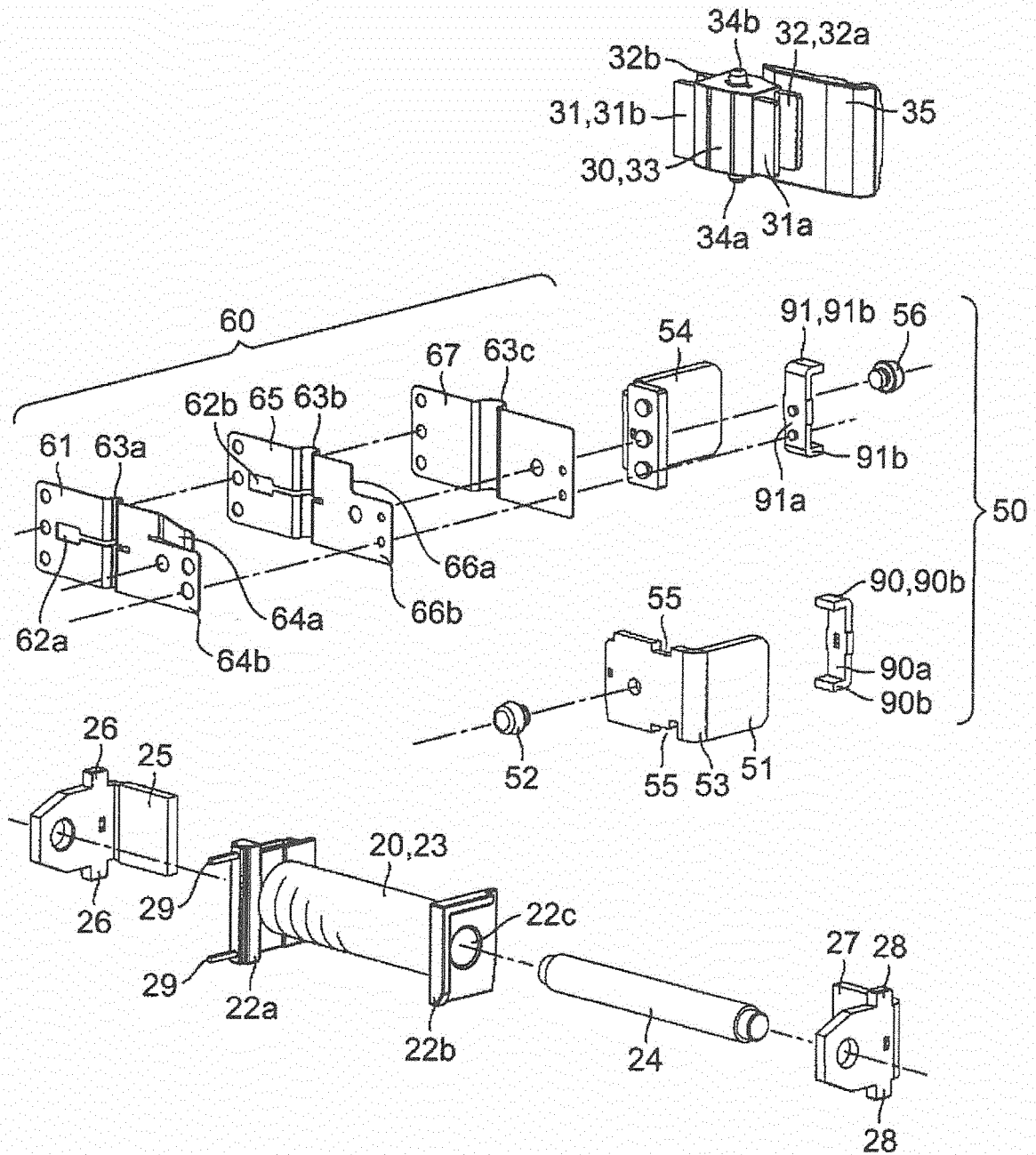


Fig.6A

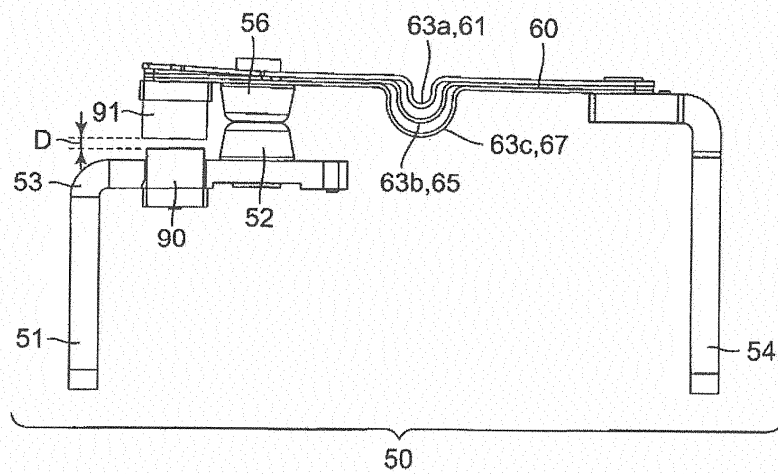


Fig.6B

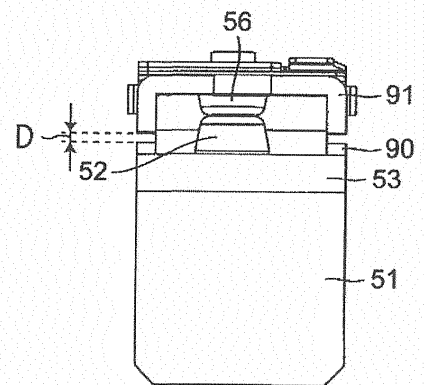


Fig. 7A

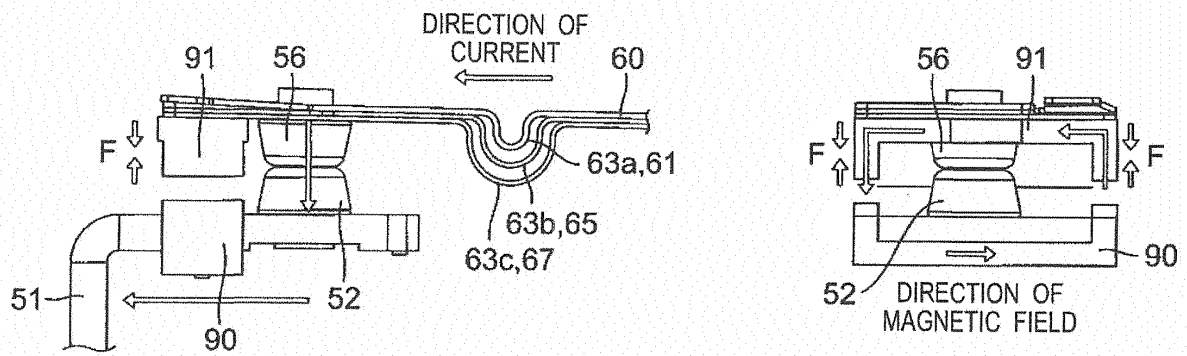


Fig. 7B

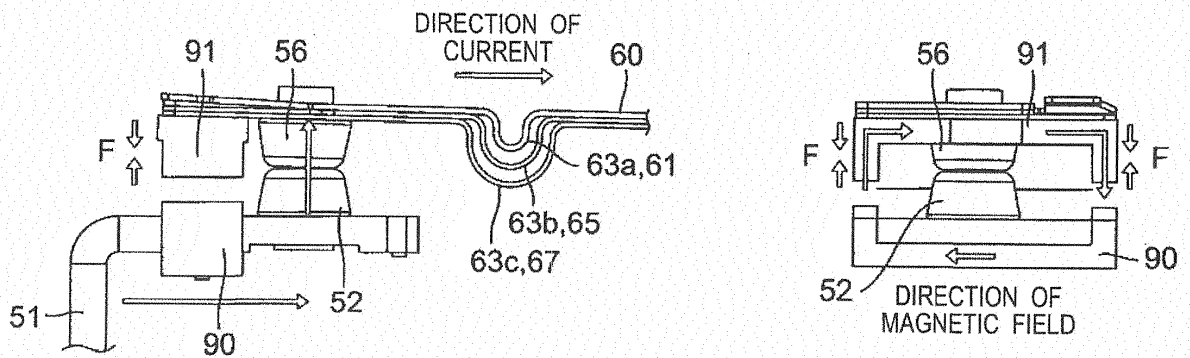


Fig.8A

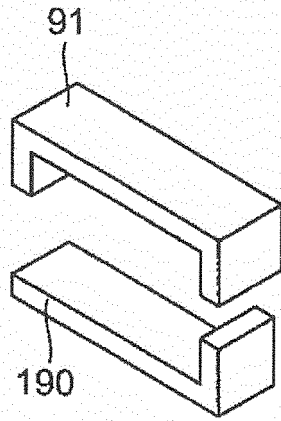


Fig.8C

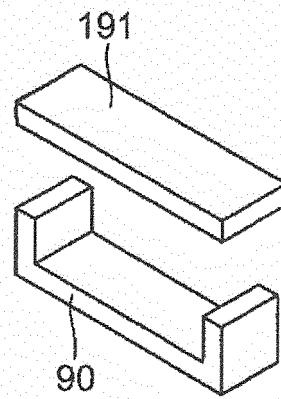


Fig.8B

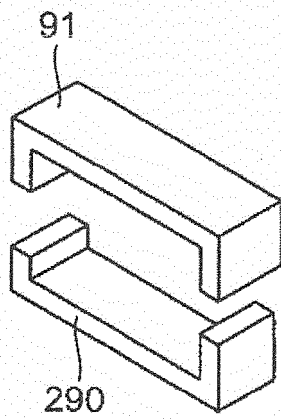


Fig.8D

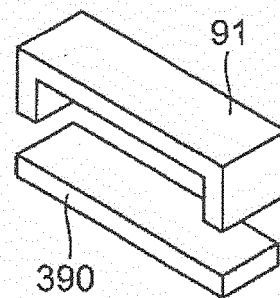


Fig. 9

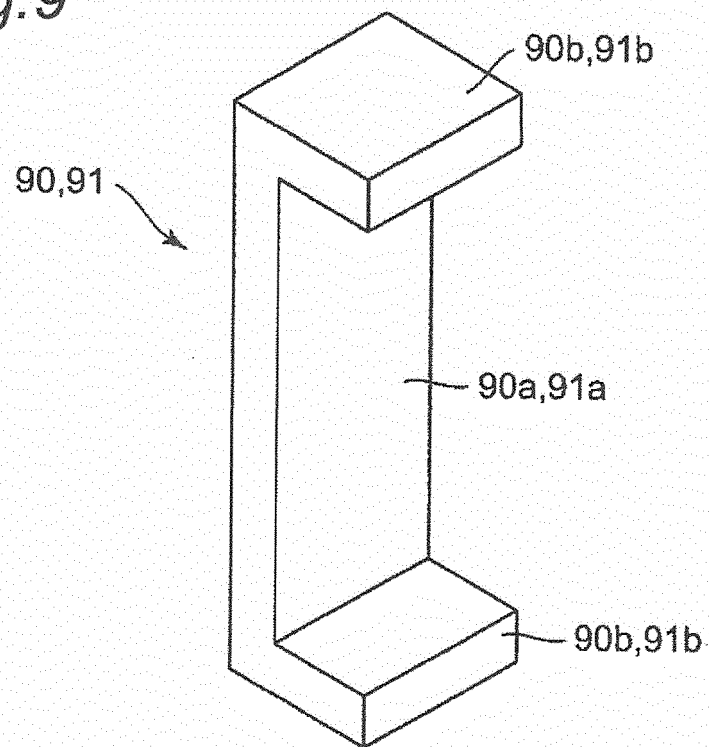


Fig. 10

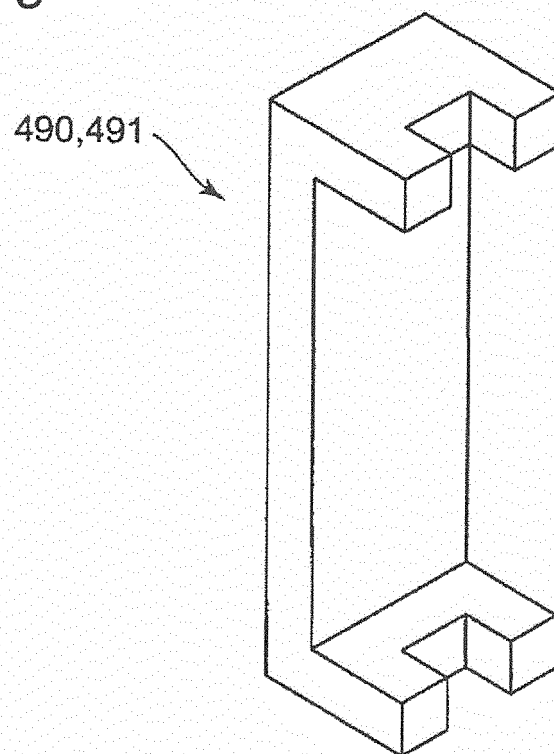


Fig. 11

590,591

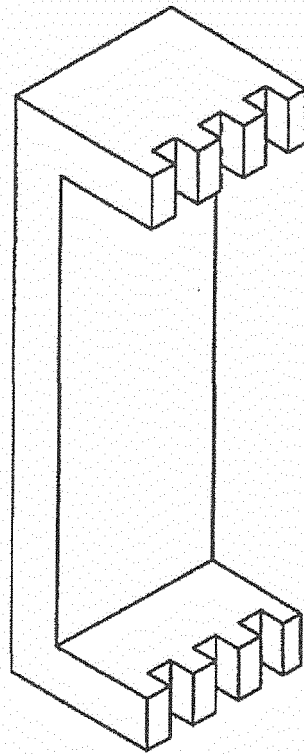


Fig. 12

690,691

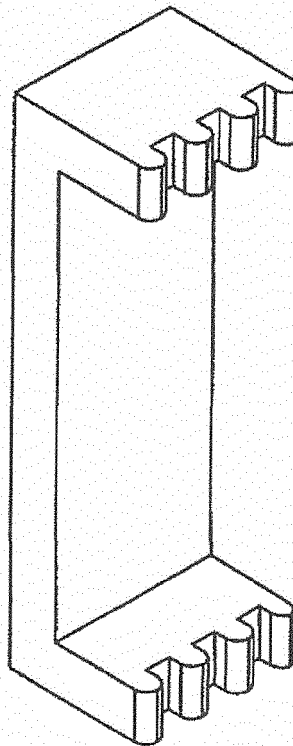


Fig. 13

790,791

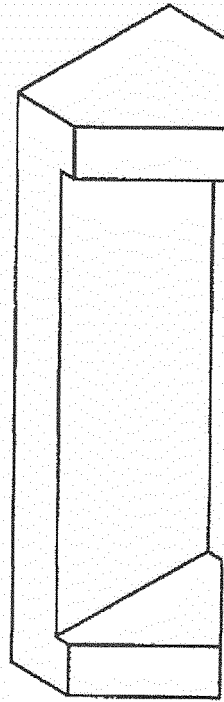


Fig. 14

890,891

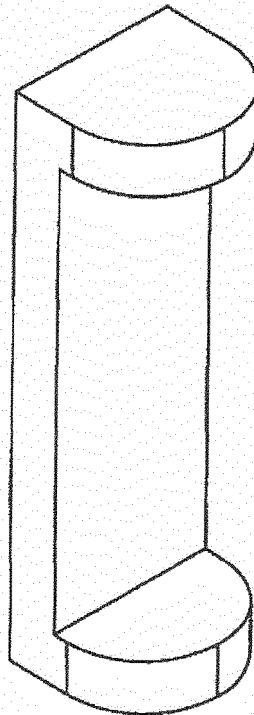
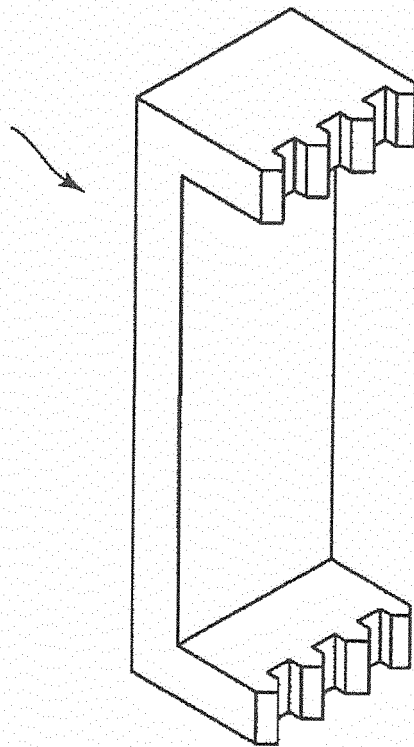


Fig. 15

990,991



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2014/066177

A. CLASSIFICATION OF SUBJECT MATTER

H01H50/56(2006.01) i

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)

H01H50/56, H01H50/42

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

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014

Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 6-103878 A (Matsushita Electric Works, Ltd.), 15 April 1994 (15.04.1994), entire text; all drawings (Family: none)	1-4, 6, 7, 9, 10 5, 8
Y	JP 4-19937 A (Matsushita Electric Works, Ltd.), 23 January 1992 (23.01.1992), page 1, lower right column, line 1 to page 2, upper left column, line 5; fig. 6 to 8 (Family: none)	5
Y	JP 2000-164100 A (Matsushita Electric Works, Ltd.), 16 June 2000 (16.06.2000), paragraphs [0048], [0049]; fig. 5 (Family: none)	8

☐ Further documents are listed in the continuation of Box C.
☐ See patent family annex.

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Date of the actual completion of the international search
23 July, 2014 (23.07.14)Date of mailing of the international search report
05 August, 2014 (05.08.14)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

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Form PCT/ISA/210 (second sheet) (July 2009)

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Patent documents cited in the description

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