

EUROPEAN PATENT APPLICATION

Application number: 89115585.5

Int. Cl.⁴: H01H 51/22

Date of filing: 23.08.89

Priority: 25.08.88 JP 212909/88
 26.09.88 JP 240253/88
 28.04.89 JP 109929/89
 02.05.89 JP 113229/89
 10.05.89 JP 116431/89

Date of publication of application:
 28.02.90 Bulletin 90/09

Designated Contracting States:
 AT BE CH DE ES FR GB GR IT LI NL SE

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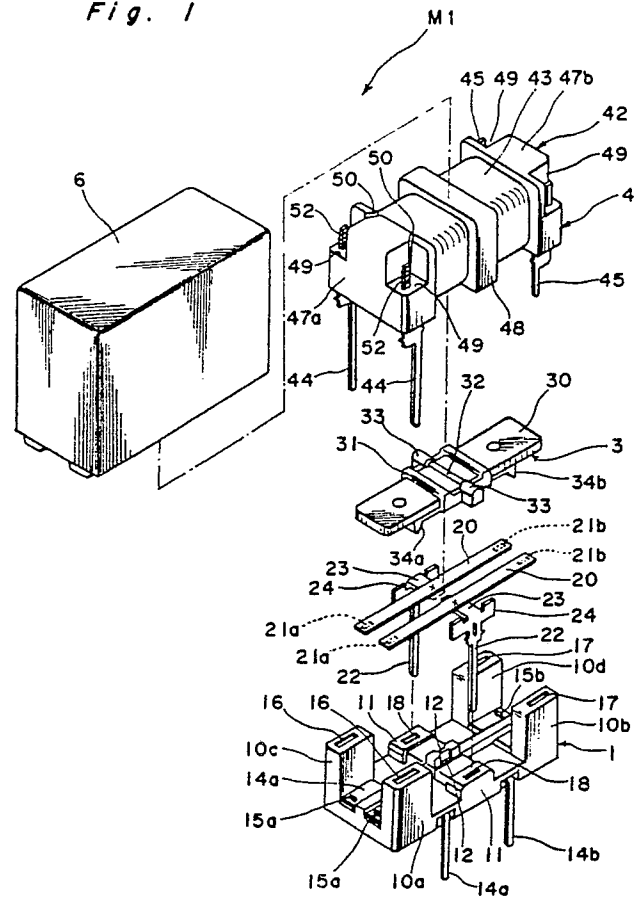
Electromagnetic relay.

An electromagnetic relay which includes a base, fixed contact terminals having fixed contacts, and movable contact terminals supporting intermediate portions of movable contact arms each provided, at opposite ends thereof, with movable contacts confronting the fixed contacts, with the fixed contact terminals and the movable contact terminals being forced into the base to be fixed in it, an electromagnet block in which a coil is wound, through a spool, onto a core generally in an inverted U-shape provided with a permanent magnet at its central portion,

and an armature block attracted and pivotally held by the permanent magnet so that opposite ends of the armature block confront pole face of the core. The electromagnet block is assembled above the movable contact arms, so as to allow the contacts to be closed through depression of the movable contact arms by the armature block.

EP 0 355 817 A2

Fig. 1



ELECTROMAGNETIC RELAY

BACKGROUND OF THE INVENTION

The present invention generally relates to a relay and more particularly, to an electromagnetic relay arranged to selectively open or close contacts through pivotal movements of an armature block or movable member.

Conventionally, there has been proposed for example, in Japanese Laid-Open Utility Model Publication Jikkaisho No. 62-124743, an electromagnetic relay which includes a housing constituted by a base and a casing, an electromagnet block having an approximately U-shaped core bent at opposite ends to form pole pieces and a coil wound onto said core through a spool, a permanent magnet assembled between said pole pieces and magnetized by the same polarity at its portions confronting said pole pieces, with its intermediate portion being magnetized by a polarity opposite thereto, and an armature block having its opposite ends respectively confront said pole pieces, with a protrusion formed approximately at its central portion being pivotally supported in a concave groove provided at a central part of said permanent magnet, said electromagnet block, said permanent magnet and said armature block being accommodated in said housing.

In the known arrangement as referred to above, movable contact pieces each supported at central portions are provided at the opposite sides of the armature block, and movable contacts are provided at opposite ends of the respective movable pieces for selective contacts and spacing with respect to fixed contacts of the base, while connector pieces in a T-shape are provided at the central portions of the respective movable contact pieces to project sidewise therefrom, whereby the movable contact pieces and movable contact terminal provided on said base are electrically connected through said connector pieces.

Incidentally, in the electromagnetic relays of the above described type, various adjustments should be made after assembly so as to stabilize working characteristics by matching the magnetic attracting force of the permanent magnet or electromagnet with a spring load, and in order to allow such adjustment work to be readily effected in a short time, dimensions between the principal parts such as positional relation between the fixed contacts and movable contacts, or between the armature block and electromagnet block, etc. must be maintained at high accuracy.

However, in the conventional electromagnetic relays as referred to above, since the fixed contacts are disposed on the base, and the movable

contacts are provided at opposite ends of the movable contact pieces of the armature block, while said armature block is supported on the permanent magnet block accommodated in the base to be assembled, the positional relation between the fixed contacts and movable contacts affects the accuracy for assembling the electromagnet onto the base, and that for assembling the permanent magnet onto the electromagnet block. Meanwhile, due to the construction that the core of the electromagnet block is formed into one unit with the spool, while the armature block is supported on the permanent magnet placed on the electromagnet block, the positional relation between the pole face of the core for the electromagnet block and the pole portion of the armature block also affects the assembling accuracy of the electromagnet onto the electromagnet block.

As described above, the positional relations between the principal parts which may determine the working characteristics of the electromagnetic relay, depend on the assembling accuracy of the respective parts, even if the dimensional accuracies of the four parts such as the base, electromagnet block, permanent magnet and armature block are sufficiently high in themselves. Accordingly, errors produced during assembly of the respective parts are accumulated, thus giving rise to large errors in the positional relations between the principal parts, which may scatter among individual electromagnetic relays. Consequently, working characteristics are not uniform from product to product, and troublesome procedures become necessary for the adjustments, thus requiring much man-hour, with a simultaneous increase of the manufacturing cost.

SUMMARY OF THE INVENTION

Accordingly, an essential object of the present invention is to provide an electromagnetic relay which has less accumulation of errors during assembly of parts, thereby making it possible to determine the positional relation between principal parts at high accuracy, with adjustments of contact pressure being also facilitated.

Another object of the present invention is to provide an electromagnetic relay of the above described type in which the material for movable contact pieces employed therein may be selected from a wide range of materials, and contact fusion does not readily take place, while the relay compact and thin in size has a small power consumption.

A further object of the present invention is to provide an electromagnetic relay of the above described type which is simple in construction and stable in functioning, and can be readily manufactured at low cost.

In accomplishing these and other objects, according to one aspect of the present invention, there is provided an electromagnetic relay which includes a base, fixed contact terminals having fixed contacts and movable contact terminals supporting intermediate portions of movable contact arms each provided, at opposite ends thereof, with movable contacts confronting said fixed contacts, with the fixed contact terminals and movable contact terminals being forced into the base to be fixed therein, an electromagnet block in which a coil is wound, through a spool, onto a core generally in an inverted U-shape provided with a permanent magnet at its central portion, and an armature block attracted and pivotally held by the permanent magnet so that opposite ends of said armature block confront pole face of said core. The electromagnet block is assembled above the movable contact arms, thereby to allow the contacts to be closed through depression of said movable contact arms by the armature block.

By the construction of the present invention as described above, since the fixed contact terminals having the fixed contacts and the movable contact terminals having the movable contacts are both forced into the base to be secured therein, the positional relation between the fixed contacts and movable contacts is determined based on the base, and is not affected by the assembling accuracy during mounting of the electromagnet block onto the base. Meanwhile, owing to the construction that the armature block is held by the permanent magnet of the electromagnet block, the positional relation between the pole portions thereof and the pole faces of the core of the electromagnet block depends only on the assembling accuracy of the armature block onto the electromagnet block.

In another aspect of the present invention, there is provided an electromagnetic relay which includes a base, movable contact terminals fixed to said base, movable contact arms each having movable contacts at its opposite ends and welded, at its central portion, to said movable contact terminals so as to be supported, fixed contact terminals each having fixed contacts contacting under pressure from above, said movable contacts of said movable contact arms and forced into said base so as to be fixed, an electromagnet block in which a coil is wound, through a spool, onto a core generally in an inverted U-shape provided with a permanent magnet at its central portion, and an armature block attracted and pivotally held by the permanent magnet so that opposite ends of said

armature block confront pole face of said core. The electromagnet block is assembled onto the base so as to be located above said movable contact arms, thereby to allow the contacts to be opened through depression of said movable contact arms by said armature block.

In the above arrangement according to the present invention, since the movable contact pieces having the movable contacts are welded to the movable contact terminals secured to the base, while the fixed contact terminals having the fixed contacts are forced into the base for being secured therein, the positional relation between the fixed contacts and movable contacts is also determined based on the base, without being affected by the assembling accuracy during mounting of the electromagnet block onto the base. Similarly, owing to the arrangement that the armature block is held by the permanent magnet of the electromagnet block, the positional relation between the pole portions thereof and the pole faces of the core of the electromagnet block depends only on the assembling accuracy of the armature block onto the electromagnet block.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become apparent from the following description taken in conjunction with the preferred embodiment thereof with reference to the accompanying drawings, in which;

Fig. 1 is an exploded perspective view of an electromagnetic relay M1 according to one preferred embodiment of the present invention,

Fig. 2 is a side sectional view of the electromagnetic relay M1 of Fig. 1,

Fig. 3 is a fragmentary perspective view of an electromagnet block as viewed from a reverse side thereof, which is employed in the arrangement M1 of Fig. 1,

Fig. 4 is an exploded perspective view of an electromagnetic relay M2 according to a second embodiment of the present invention,

Fig. 5 is a side sectional view of the electromagnetic relay M2 of Fig. 4, and

Fig. 6 is a fragmentary perspective view of an electromagnet block as viewed from a reverse side thereof, which is employed in the arrangement of Fig. 4,

Fig. 7 is an exploded perspective view of an electromagnetic relay M3 according to a third embodiment of the present invention,

Fig. 8 is a side sectional view of the electromagnetic relay M3 of Fig. 7,

Fig. 9 is a diagram for explaining an arrangement for adjusting contact pressure as employed in

the electromagnet block of Fig. 7.

Fig. 10 is a block diagram for explaining electrical connections for the contact pressure adjustment in Fig. 9.

Fig. 11 is an exploded perspective view of an electromagnetic relay M4 according to a fourth embodiment of the present invention.

Fig. 12 is a side sectional view of the electromagnetic relay M4 of Fig. 11.

Figs. 13 and 14 are diagrams respectively showing positional relations between the movable members and movable contact pieces when the electromagnetic relay M4 of Fig. 11 is used as a self-restoration type and a self-retaining type.

Fig. 15 is an exploded perspective view of an electromagnetic relay M5 according to a fifth embodiment of the present invention.

Fig. 16 is a side sectional view of the electromagnetic relay M5 of Fig. 15.

Figs. 17 and 18 are top plan view and said elevational view of a contact piece block employed in the arrangement of Fig. 15.

Figs. 19 and 22 are diagrams for explaining functions of a magnetic circuit in the arrangement of Fig. 15, and

Fig. 23 is a graph showing an attractive force characteristic of the electromagnetic relay of Fig. 11.

DETAILED DESCRIPTION OF THE INVENTION

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals throughout the accompanying drawings.

First embodiment

Referring now to the drawings, there is shown in Fig. 1, an electromagnetic relay M1 according to a first embodiment of the present invention, which generally includes a base 1, an armature block 3, an electromagnet block 4 and a casing 6.

The base 1 in a rectangular plate like configuration and made of an insulative synthetic resin has columns 10a, 10b, 10c and 10d extending upwardly from its four corners on the surface for supporting the electromagnet block 4, terminal inserting portions 11 for receiving movable contact terminals 22, provided to extend upwardly from the base 1 at opposite sides with respect to a central line in the longitudinal direction, and terminal engaging portions 12 for engagement with forward ends of support pieces 23 of the movable contact terminals 22, provided at the central portion of said base. Moreover, at the opposite ends of the base 1 in its

longitudinal direction, two sets of fixed contact terminals 14a and 14b are integrally provided by insert molding, and upper ends of said fixed contact terminals 14a and 14b are bent in a horizontal direction so as to be exposed on the upper surface of the base 1. On the upper surfaces of the fixed contact terminals 14a and 14b, fixed contacts 15a and 15b are provided, with the lower ends of said fixed contact terminals 14a and 14b extending downwardly from side faces of the base 1 as shown. In the upper faces of the columns 10a and 10c, holes or bores 16 for coil terminals are formed, and in the upper faces of the columns 10b and 10d, holes 17 for receiving dummy terminals are formed. Meanwhile, in the upper faces of the movable contact terminal inserting portions 11, holes 18 are formed to receive the set of the movable contact terminals 22 to which movable contact pieces 20 are secured. More specifically, the movable contact pieces 20 are electro-conductive members having resiliency, and respectively formed with movable contacts 21a and 21b on the under faces at the opposite ends thereof. The upper ends of the movable contact terminals 22 are folded in a horizontal direction to confront each other so as to form support pieces 23, with stopper pieces 24 being formed in the vicinity of said support pieces 23, and the movable contact pieces 20 are each fixed, at central portions thereof, to said support pieces 23 by caulking or welding. The movable contact terminals 22 are forced into the holes 18 of the inserting portions 11 from above, and assembled, with the stopper pieces 24 contacting the upper faces of the inserting portions 11, and with the forward ends of the support pieces engaged with the terminal engaging portions 12, and thus, as shown in Fig. 2, the movable contacts 21a and 21b confront the fixed contacts 15a and 15b through working spaces Sa and Sb.

The armature block 3 includes an armature 30 of a magnetic material in a rectangular configuration, and an insulating member 31 made of a synthetic resin and integrally formed at the central portion of said armature 30. At the central portion on the upper surface of the armature 30, a holding portion 32 having a semi-circular cross section and extending in a direction normal to the longitudinal direction is formed. Moreover, on opposite sides at the central portion of the upper surface of the insulating member 31, guide pin portions 33 are formed in positions close to the opposite ends of said holding portion 32, while on the under surface of the insulating member 31, in positions spaced from the central portion by an equal distance in the longitudinal direction, depressing portions or protrusions 34a and 34b each extending in a direction normal to the longitudinal direction are provided. This armature block 3 is pivotally supported about

the contact point between the holding portion 32 and the permanent magnet 41 by causing the holding portion 32 thereof to be attracted from below, onto the permanent magnet 41 of the electromagnet block 4 to be mentioned later, with the guide pin portions 33 engaged in a bearing portion 51 of a spool 42. Furthermore, upon mounting the electromagnet block 4 onto the base 1, the depressing portions 34a and 34b of this armature block 3 are arranged to be pressed against the movable contact pieces 20 referred to earlier.

The electromagnet block 4 generally includes a core 40, the permanent magnet 41, the spool 42, a coil 43, coil terminals 44 and dummy or auxiliary terminals 45.

The core 40 made of a magnetic material has a generally U-shape, with opposite ends thereof bent downwardly as shown in Fig. 2, and its under faces at the bent opposite end portions are formed into pole faces 46a and 46b.

The permanent magnet 41 is a rectangular parallelepiped member magnetized with N pole at the lower portion, and S pole at the upper portion, and attracted to the central portion of said core 40 as shown in Fig. 2.

The spool 42 is integrally formed with the core 40 and the permanent magnet 41 by the insert molding so as to cover said core and permanent magnet, and is provided with flange portions 47a, 47b and 48 at its opposite ends and central portion. On the under surfaces of the flange portions 47a and 47b at the opposite ends, the pole faces 46a and 46b of the core 40 are exposed, while, at the upper corner portions thereof, recesses 49 are formed, and especially, at the upper surfaces of the flange portion 47a, coil drawing out grooves 50 communicated with the recesses 49 are formed. On the under surface of the central flange portion 48, the N pole of the permanent magnet 41 is exposed as shown in Fig. 3, with the bearing portion 51 having a semi-circular cross section being formed at the opposite sides of said permanent magnet 41.

The coil 43 is wound around the portions of the spool 42 between the flange portions 47a and 47b at the opposite ends and the flange portion 48 at the central portion, and both ends of the coil 43 are led into the recesses 49 through the coil drawing out grooves 50 referred to earlier so as to be wound around coil winding portions 52 of the coil terminals 44 to be mentioned below.

The coil terminals 44 are forced into the under surface of the flange portion 47a at the left side of the spool 42 as shown in Fig. 1, and the upper ends of said coil terminals 44 project into the recesses 49 to provide the coil winding portions 52 referred to above.

The dummy terminals 45 are also forced into

the under surface of the flange portion 47b at the right side of the spool 42 in Fig. 1, with the upper ends thereof extending upwardly into the recesses 49. These dummy terminals 45 are intended to fix the electromagnet block 4 by inserting the lower ends thereof into the dummy terminal receiving holes 17 formed on the base 1.

The casing 6 in the rectangular box-like configuration is fitted over the base 1 onto which the electromagnet block 4 is applied, and is sealed by a sealing material 7 as shown in Fig. 2.

Subsequently, assembling of the electromagnetic relay having the construction as described so far will be explained.

In the first place, the coil terminals 44 are forced into the spool 42 integrally formed with the core 40 and the permanent magnet 41 preliminarily by the insert molding, and the coil 43 is wound onto the spool 42, with the opposite ends of said coil 43 being wound onto the winding portions 52 of the coil terminals 44, and thus, the electromagnet block 4 is formed. Then, at the under side of said electromagnet block 4, the armature block 3 is held on the under surface of the permanent magnet 41, with the holding portion 32 of the armature block 3 attracted by the permanent magnet 41, and with the guide pin portions 33 engaged with the bearing portion 51, whereby the armature block 3 is pivotally supported for pivotal movement about the contact point of the holding portion 32 and the permanent magnet 41, while being restricted for the movement in a horizontal direction through engagement between the guide pin portions 33 and the bearing portion 51. Pole portions 30a and 30b at the opposite ends of the armature 30 are magnetized with the magnetic polarity at the lower end of the permanent magnet 41, i.e. with the N pole, and working spaces Ma and Mb are formed with respect to the pole face 46 of the core 40 magnetized with the same polarity as the S pole at the upper end of said permanent magnet 41, and thus, a magnetic circuit connecting the permanent magnet 41, the core 40 and the armature 30 is constituted.

Meanwhile, the movable contact terminals 22 to which the movable contact pieces 20 are secured are forced into the movable contact terminal receiving holes 18 of the inserting portions 11 of the base 1 integrally formed with the fixed contact terminals 14a and 14b by the insert molding, until the stopper pieces 24 of the movable contact terminals 22 contact the upper surface of the inserting portions 11 and the forward ends of the support pieces 23 engage the terminal engaging portions 12, whereby working spaces Sa and Sb are formed between the movable contacts 21a and 21b and the fixed contacts 15a and 15b.

Thereafter, by forcing the coil terminals 44 and

dummy terminals 45 of the electromagnet block 4 on which the armature block 3 is held in the above described manner, into holes 16 and 17 of the base 1 respectively, said electromagnet block 4 is assembled onto the base 1, whereby the depressing portions 34a and 34b of the armature block 3 depress the movable contact pieces 20. Actually, since the armature block 3 is in an inclined state, and one of the pole portions, for example, the pole portion 30a is attracted onto the pole face 46a of the core 40, with the depressing portion 34b depressing the movable contact piece 20, and with the other depressing portion 34a being retreated upwardly from said movable contact piece 20, the movable contacts 21b contact the fixed contacts 15b under pressure, while the movable contacts 21a are spaced from the fixed contacts 15a for opening.

In the above state, the casing 6 is fitted onto the base 1 in such a manner as said casing is applied onto the electromagnet 4, and the sealing agent 7 is applied between the casing 6 and the base 1 for sealing as shown in Fig. 2.

As described so far, in the present embodiment, the fixed contact terminals 14a and 14b, and the movable contact terminals 22 to which the movable contact pieces 20 are fixed, are directly assembled onto the base 1. In the above arrangement, since the fixed contact terminals 14a and 14b are integrally formed with the base 1 by the insert molding, the positional relation of the fixed contacts 15a and 15b may be determined at high accuracy. Although, the positions of the movable contacts 21a and 21b are mainly affected by the fixing positions of the movable contact pieces 20 onto the movable contact terminals 22 and the positions of the holes 18 for inserting the movable contact terminals 22 into the base 1, since such fixing of the movable contact pieces 20 onto the movable contact terminals 22 are accurately effected at the stage of part processing and the holes 18 are preliminarily formed during molding of the base 1, the positional relation of the movable contacts 21a and 21b can be determined at high accuracy.

Meanwhile, since the core 40 of the electromagnet block 4 and the permanent magnet 41 are integrally molded with the spool 42 by the insert molding, positional relations thereof may also be determined at high accuracy. Moreover, although the position of the armature block 3 is affected by the position of the bearing portion 51 for restricting the displacement thereof in a horizontal direction, and the mounting accuracy of said block 3 onto the electromagnet block 4, since the bearing portion 51 is preliminarily formed during molding of the spool 42, with the assembling thereof being effected at relatively high accuracy through engagement be-

tween the guide pin portion 33 and the bearing portion 51, the positional relation between the pole faces 46a and 46b of the core 40, and the pole portions 30a and 30b at the opposite ends of the armature 30 can be determined at high accuracy.

As described so far, the positional relation between the fixed contacts 15a and 15b and the movable contacts 21a and 21b may be determined on the basis of the base 1, and is not affected by the accuracy for mounting the electromagnet block 4 onto the base 1. Furthermore, the positional relation between the pole faces 46a and 46b of the core 40, and the pole portions 30a and 30b of the armature 30 can be determined based on the spool 42 of the electromagnet block 4, and is not influenced by the assembling accuracy of the electromagnet onto the base 1.

Accordingly, accumulated errors due to assembling of parts are decreased, with consequent reduction of deviation in the assembling accuracy between finished electromagnetic relays for stable working characteristics, and thus, adjusting work may be simplified for reduction of man-hour required for the assembly.

In the electromagnet relay according to the first embodiment of the present invention as described above, since the contact mechanism is provided below the electromagnet block 4 within a projection area thereof, floor area may be reduced, different from the conventional construction in which the contact mechanism is provided at opposite sides of the electromagnet block, whereby the mounting area with respect to the printed circuit board becomes smaller, with a consequent increase of the mounting density.

Moreover, in the above first embodiment, since the movable contact pieces 20 are fixed to the movable contact terminals 22 which are forced into the base 1 for securing, the movable contact pieces 20 are rigidly supported for stable functioning, different from the conventional construction in which movable contact pieces are connected to the movable contact terminals through the T-shaped connector pieces.

Furthermore, owing to the fact that the armature 30 and the movable contact pieces 20 are constituted by different blocks, the arrangement of the present invention is different from the conventional construction in which the armature and movable contact pieces are formed into one unit, while the pivotal movement of the armature block is obstructed by the twisting rigidity of the T-shaped connector pieces, and the pivotal movement in a see-saw fashion may be effected only by the armature 30 for stabilization of the functioning characteristics.

Additionally, since the contact mechanism is disposed below the electromagnet block 4, such

electromagnet block may be increased in its size without being restricted by the contact mechanism to achieve a higher sensitivity of the coil.

Moreover, since the electromagnet block 4 is supported on the base 1 by the four columns 10a to 10d, the adjustment of the contact mechanism disposed thereunder may be readily effected through spaces defined between said columns.

Subsequently, functioning of the electromagnetic relay having constructions as described so far will be explained.

When the electromagnet block 4 is in a de-energized state, with no current being fed to the coil 43 through the coil terminals 44, the armature block 3 has, for example, its left side pole portion 30a of the armature 30, attracted to the pole face 46a of the core 40, and is maintained in an inclined state as it rotates clockwise in Fig. 2. Thus, the depressing portion or protrusion 34b of the armature block 3 depresses the movable contact piece 20 downwards, and the depressing portion 34a retreats upwards from the movable contact piece 20, while the movable contacts 21b contact the fixed contacts 15b under pressure, with the movable contacts 21a being in a state spaced from the fixed contacts 15a.

Upon feeding current into the coil 43 for energization of the electromagnet block 4 so that the pole face 46a of the core 40 becomes N pole, and the pole face 46b thereof assumes S pole, the armature block 3 effects the pivotal movement in the counterclockwise direction in Fig. 2 based on the magnetic attraction between the right side pole portion 30b of the armature 30 and the pole face 46b of the core 40, whereby the depressing portion 34a depresses the movable contact piece 20 downwards, with the depressing portion 34b retreating upwards from the movable contact piece 20, and thus, the movable contacts 21a are closed to the fixed contacts 15a, while the movable contacts 21b are spaced from the fixed contacts 15b.

When the current to the coil 43 is changed over to be reversed for energization so that the pole face 46a of the core 40 assumes S pole, and the pole face 46b becomes N pole, the armature block 3 effects pivotal movement in the clockwise direction in Fig. 2, based on the magnetic attraction between the left side pole portion 30a of the armature 30 and the pole face 46a of the core 40, and thus, the movable contacts 21a are spaced from the fixed contacts 15a, and the movable contacts 21b are closed on the fixed contacts 15b.

As is seen from the foregoing description, according to the first embodiment of the present invention, since the positional relations for the principal parts are determined on the basis of the base, without any accumulation of errors during assembling of parts, high dimensional accuracy may be

achieved. Moreover, scattering in accuracy is not present among finished products to maintain uniform quality for stable functioning characteristics, and thus, adjusting work may be facilitated for reduction of man-hour required for the adjustments.

Second embodiment

Referring further to Figs. 4, 5 and 6, there is shown in Fig. 4, an electromagnetic relay M2 according to a second embodiment of the present invention, which also includes a base 101, an armature block 103, an electromagnet block 104 and a casing 106 in the similar manner as in the first embodiment of Figs. 1 to 3.

The base 101 also having a rectangular plate-like shape and made of an insulative synthetic material has an insulating wall 110 extending along the center axis in a longitudinal direction thereof, and columns 111a, 111b, 111c, and 111d extending upwardly from its four corners for supporting the electromagnet block 104. On the projecting portions 112 extending upwardly from opposite sides at the central portion of the insulating wall 110, movable contact terminals 113 are integrally formed by the insert molding, and the upper ends of said movable contact terminals 113 are folded in a horizontal direction to be exposed over the upper surfaces of the projecting portions 112, while the lower ends of said terminals 113 extend downwardly from the side portions of the base 101. In the upper faces of the columns 111a and 111c, holes 114 for receiving coil terminals are formed, and in the upper faces of the columns 111b and 111d, holes 115 for receiving dummy terminals are provided, while, at base portions of the respective columns 111a, 111b, 111c and 111d, holes 116a and 116b for receiving fixed contact terminals are formed. The upper portions of the projecting portions 112 are further extended upwardly to form bearing portions 117 in which guide pin portions 133 of the armature block 103 are engaged.

To the above movable contact terminals 113, movable contact pieces 118 are each welded at its central portion to be supported thereat. Each of said movable contact pieces 118 is made of a resilient electrically conductive material, and formed, on the upper face at its opposite ends, with movable contacts 119a and 119b. Meanwhile, two sets of fixed contact terminals 120a and 120b are forced into the holes 116a and 116b for said fixed contact terminals. The upper ends of the fixed contact terminals 120a and 120b are bent in a horizontal direction, with fixed contacts 121a and 121b are provided at reverse faces thereof, and said fixed contacts 121a and 121b are held in contact with the movable contacts 119a and 119b

of the movable contact pieces 118 under a pre-determined contact pressure, with the lower ends of said terminals extending downwardly from the bottom face of said base 1.

The armature block 103 has the construction generally similar to that in the first embodiment of Figs. 1 to 3, and includes an armature 130 of a magnetic material in a rectangular configuration, and an insulating member 131 made of a synthetic resin and integrally formed at the central portion of said armature 130. At the central portion on the upper surface of the armature 130, a holding portion 132 having a semi-circular cross section and extending a direction normal to the longitudinal direction is formed. Moreover, on opposite sides at the central portion on the upper surface of the insulating member 131, the guide pin portions 133 are formed in positions close to the opposite ends of said holding portion 132, while on the under surface of the insulating member 131, in positions spaced from the central portion by an equal distance in the longitudinal direction, depressing portions or protrusions 134a and 134b each extending in a direction normal to the longitudinal direction are provided. This armature block 103 is pivotally supported about the contact point between the holding portion 132 and the permanent magnet 141 by causing the holding portion 132 thereof to be attracted from below, onto the permanent magnet 141 of the electromagnet block 104, with the guide pin portions 133 engaged in a bearing portion 150 of a spool 142. Furthermore, upon mounting the electromagnet block 104 onto the base 101, the depressing portions 134a and 134b of this armature block 103 are arranged to be pressed against the movable contact pieces 118 as referred to earlier.

The electromagnet block 104 generally includes a core 140, the permanent magnet 141, the spool 142, a coil 143, coil terminals 144 and dummy terminals 145.

The core 140 made of a magnetic material has a generally U-shape, with opposite ends thereof bent downwardly as shown in Fig. 5, and its under faces at the bent opposite end portions are formed into pole faces 146a and 146b.

The permanent magnet 141 is a rectangular parallelepiped member magnetized with N pole at the lower portion, and S pole at the upper portion, and attracted to the central portion of said core 140 as shown in Fig. 5.

The spool 142 is integrally formed with the core 140 and the permanent magnet 141 by the insert molding so as to cover said core and permanent magnet, and is provided with flange portions 147a, 147b and 148 at its opposite ends and central portion. On the under surfaces of the flange portions 147a and 147b at the opposite ends, the

pole faces 146a and 146b of the core 140 are exposed, while, at the upper corner portions thereof, especially, at the upper surface of the flange portion 147a, a coil drawing out groove 149 is formed. On the under surface of the central flange portion 148, the N pole of the permanent magnet 141 is exposed as shown in Fig. 6, with the bearing portion 150 having a semi-circular cross section being formed at the opposite sides of said permanent magnet 141.

On the upper surface of the flange portion 148, coil leading grooves 151 during winding of the coil 143 are formed.

The coil 143 is wound around the portions of the spool 142 between the flange portions 147a and 147b at the opposite ends and the flange portion 148 at the central portion, and both ends of the coil 143 are led through the groove 149 so as to be wound around coil winding portions 152 of the coil terminals 144 to be mentioned below.

The coil terminals 144 are forced into the under surface of the flange portion 147a at the left side of the spool 142 as shown in Fig. 4, and the upper ends of said coil terminals 144 project to provide the coil winding portions 152.

The dummy terminals 145 are also forced into the under surface of the flange portions 147b at the right side of the spool 142 in Fig. 4. These dummy terminals 145 are intended to fix the electromagnet block 104 by inserting the lower ends thereof into the dummy terminal receiving holes 117 formed on the base 101.

The casing 106 in the rectangular box-like configuration is fitted over the base 101 onto which the electromagnet block 104 is applied, and is sealed by a sealing material 107 as shown in Fig. 5.

Subsequently, assembling of the electromagnetic relay of the second embodiment as described so far will be explained.

Firstly, the coil terminals 144 are forced into the spool 142 integrally formed with the core 140 and the permanent magnet 141 preliminarily by the insert molding, and the coil 143 is wound onto the spool 142, with the opposite ends of said coil 143 being wound onto the winding portions 152 of the coil terminals 144, and thus, the electromagnet block 104 is formed. Then, at the under side of said electromagnet block 104, the armature block 103 is held on the under surface of the permanent magnet 141, with the holding portion 132 of the armature block 103 attracted by the permanent magnet 141, and with the guide pin portions 133 engaged with the bearing portion 150, whereby the armature block 103 is pivotally supported for pivotal movement about the contact point of the holding portion 132 and the permanent magnet 141, while being restricted for the movement in a horizontal direction through engagement between the

guide pin portions 133 and the bearing portion 150. The pole portions 130a and 130b at the opposite ends of the armature block 130 are magnetized with the magnetic polarity at the lower end of the permanent magnet 141, i.e. with the N pole, and working spaces Ma and Mb are formed with respect to the pole face 146 of the core 140 magnetized with the same polarity as the S pole at the upper end of said permanent magnet 141, and thus, a magnetic circuit connecting the permanent magnet 141, the core 140 and the armature block 103 is constituted.

Meanwhile, after welding the movable contact pieces 118, each at its central portion, onto the upper surfaces of the movable contact terminals 113 integrally formed with the base 101 by the insert molding, the fixed contact terminals 120a and 120b are forced into the receiving holes 116a and 116b in such a manner that the fixed contacts 121a and 121b thereof are brought into contact with the movable contacts 119a and 119b from above, whereby the movable contact pieces 118 are deflected and the movable contacts 119a and 119b and the fixed contacts 121a and 121b contact each other at a predetermined contact pressure. Accordingly, at the above assembling state, i.e. at the time point for assembling the contact mechanism onto the base 101, adjustments of the contact pressure may be effected by adjusting the inserting pressure of the fixed contact terminals 120a and 120b.

Thereafter, by forcing the coil terminals 144 and dummy terminals 145 of the electromagnet block 104 on which the armature block 103 is held in the above described manner, into the receiving holes 114 and 115 of the base 101 respectively, said electromagnet block 104 is assembled onto the base 101, whereby the guide shaft portions 133 of the armature block 103 engage the bearing portions 117 of the base 101 so as to prevent downward falling of the armature block 103 due to vibrations, impacts, etc.

Simultaneously, the depressing portions 134a and 134b of the armature block 103 depress the movable contact pieces 120. Actually, since the armature block 103 is in an inclined state, and one of the pole portions, for example, the pole portions 130a is attracted onto the pole face 146a of the core 140, with the depressing portion 134b depressing the movable contact piece 118, and with the other depressing portion 134a being retreated upwardly from said movable contact piece 118, the movable contacts 119a contact the fixed contacts 121a under pressure, while the movable contacts 119b are spaced from the fixed contacts 121b for opening.

In the above state, the casing 106 is fitted onto the base 101 in such a manner as said casing is

applied onto the electromagnet 104, and the sealing magnet 107 is applied between the casing 106 and the base 101 for sealing as shown in Fig. 5.

As described so far, in the present embodiment, the fixed contact terminals 120a and 120b, and the movable contact pieces 118 are directly assembled onto the base 101. In the above arrangement, although the movable contact pieces 118 are welded to the movable contact terminals 113, since the movable contact terminals 113 are integrally formed with the base 101 by the insert molding and welding to the terminals 113 may be effected accurately as compared with pressure insertion, etc., the positional relation of the movable contacts 119a and 119b may be determined at high accuracy. Although the positions of the fixed contacts 121a and 121b are mainly affected by the positions of the inserting holes 116a and 116b for inserting the fixed contact terminals 120a and 120b into the base 101, since the holes 116a and 116b are preliminarily formed during molding of the base 101, the positional relation of the fixed contacts 121a and 121b can be determined at high accuracy.

Meanwhile, since the core 140 of the electromagnet block 104 and the permanent magnet 141 are integrally molded with the spool 142 by the insert molding, positional relations thereof may also be determined at high accuracy. Moreover, although the position of the bearing portion 150 for restricting the displacement thereof in a horizontal direction, and the mounting accuracy of said block 103 onto the electromagnet block 104, since the bearing portion 150 is preliminarily formed during molding of the spool 142, with the assembling thereof being effected at relatively high accuracy through engagement between the guide pin portion 133 and the bearing portion 150, the positional relation between the pole faces 146a and 146b of the core 140, and the pole portions 130a and 130b at the opposite ends of the armature 130 can be determined at high accuracy.

As described so far, the positional relation between the fixed contacts 121a and 121b and the movable contacts 119a and 119b may be determined on the basis of the base 101, and is not affected by the accuracy for mounting the electromagnet block 104 onto the base 101. Furthermore, the positional relation between the pole faces 146a and 146b of the core 140, and the pole portions 130a and 130b of the armature 130 can be determined based on the spool 142 of the electromagnet block 104, and is not influenced by the assembling accuracy of the electromagnet 104 onto the base 101.

Accordingly, accumulated errors due to assembling of parts are decreased, with consequent reduction of deviation in the assembling accuracy

between finished electromagnetic relays for stable working characteristics, and thus, adjusting work may be simplified for reduction of man-hour required for the assembly.

Furthermore, although not repeatedly described here, advantages similar to those as stated with reference to the first embodiment of Figs. 1 to 3 may also be available in the second embodiment.

Subsequently, functioning of the electromagnetic relay having constructions as described so far will be explained.

When the electromagnet block 104 is in a de-energized state, with no current being fed to the coil 143 through the coil terminals 144, the armature block 103 has, for example, its left side pole portion 130a of the armature 130, attracted to the pole face 146a of the core 140, and is maintained in an inclined state as it rotates clockwise in Fig. 5. Thus, the depressing portion 134b of the armature block 103 depresses the movable contact piece 180 downwards, and the depressing portion 134a retreats upwards from the movable contact piece 180, while the movable contacts 119a contact the fixed contacts 21a under pressure, with the movable contacts 19b being in a state spaced from the fixed contacts 21b.

Upon feeding current into the coil 143 for energization of the electromagnet block 104 so that the pole face 146a of the core 140 becomes N pole, and the pole face 146b thereof assumes S pole, the armature block 103 effects the pivotal movement in the counterclockwise direction in Fig. 5 based on the magnetic attraction between the right side pole portion 130b of the armature 130 and the pole face 146b of the core 140, whereby the depressing portion 134a depresses the movable contact piece 118 downwards, with the depressing portion 134b retreating upwards from the movable contact piece 118, and thus, the movable contacts 119a are spaced from the fixed contacts 121a, while the movable contacts 119b are closed to the fixed contacts 119b.

When the current to the coil 143 is changed over to be reversed for energization so that the pole face 146a of the core 140 assumes S pole, and the pole face 146b becomes N pole, the armature block 103 effects pivotal movement in the clockwise direction in Fig. 5, based on the magnetic attraction between the left side pole portion 130a of the armature 130 and the pole face 146a of the core 140, and thus, the movable contacts 119a are closed to the fixed contacts 121a, and the movable contacts 119b are spaced from the fixed contacts 121b.

As described above, since the movable contacts 119a and 119b are spaced from the fixed contacts 121a and 121b through depression of the movable contact pieces 118 by the depressing

portions 134a and 134b of the armature block 103, even when welding at the contacts should take place, the contacts may be readily separated by the depressing force of the depressing portions 134a and 134b of the armature block 103.

As is seen from the foregoing description, according to the second embodiment of the present invention also, the positional relations for the principal parts are determined on the basis of the base, without any accumulation of errors during assembling of parts, and therefore, high dimensional accuracy may be achieved similarly. Moreover, scattering in accuracy is not present among finished products to maintain uniform quality for stable functioning characteristics, and thus, adjusting work may be facilitated for reduction of man-hour required for the adjustments.

Third embodiment

Referring further to Figs. 7 to 10, there is shown in Fig. 7 and 8, an electromagnetic relay M3 according to a third embodiment of the present invention, which generally includes a base 201, two sets of movable terminal members 202, four sets of fixed terminal members 203, a movable member 204, an electromagnet block 205, and a casing 206.

The base 201 also in a rectangular plate-like configuration and made of an insulative synthetic resin has stands or columns 211 extending upwards from the four corners on the upper surface of a base main body 210, while each of the columns 211 is formed with a terminal inserting hole 212 extending from its upper face to lower face. On the base 201, between the columns 211 along the longitudinal direction (i.e. in the direction indicated by arrows Y-Y'), support portions 213 formed with recesses 214 for receiving shaft portions 242 of the movable member 204 therein are respectively provided, while between the columns 211 and the support portions 213 in the direction of short sides (i.e. in the direction of arrows X-X'), partition walls 215a and 215b are respectively provided, with accommodating portions 216 being formed at both sides of said partition walls 215a and 215b.

In the base main body 210, there are formed terminal inserting bores or holes 217 at the base portions of the support portions 213, another sets of terminal inserting holes 218 between the columns 211 and the support portions 213, and recesses 219 at the base portions of the columns 211, while said terminal inserting holes 218 are communicated with said recesses 219 by grooves 219a.

The movable terminal members 202 are constituted by movable contact pieces 220 and common terminals 222. Each of the movable contact

pieces 220 is made of a thin electrically conductive plate material, with movable contacts 221 being provided at opposite end upper faces. Meanwhile, each of the common terminals 222 is folded at right angles at its upper portions to form a connecting portion 223, to which the movable contact piece 220 is welded at its central portion for electrical connection.

The movable contact pieces 220 of the movable terminal members 202 are respectively received in the accommodating portions 216 by forcing the common terminals 222 thereof into the inserting holes 217 of the base main body 210 so as to cause the lower ends thereof extended through the under surface for fixing.

Each of the fixed terminal members 203 is constituted by forming an arm portion 232 through extension of the upper portion of the terminal portion 231 laterally, and providing a contact base 233 by folding the upper portion of said arm portion 232 in the horizontal direction, with the lower end thereof being formed into a leg portion 235. There are also formed a fixed contact 234 on the under surface of said contact base 233, and an engaging projection 231a at the upper portion of the terminal portion 231.

When the fixed terminal members 203 are fixed by inserting the terminal portions 231 thereof into the holes 218 provided at the base portions of the columns 211, and the leg portions 231 into the recesses 219, with the arm portions 232 fitted into the groove portions 219a, the fixed contacts 234 contact the movable contacts 221 under pressure, so as to cause the movable contact arms 220 to be curved into an arcuate shape.

For adjusting the contact pressure by forcing the fixed contact members 203 into the base 201, there are available methods based on the pressure adjusting system as described hereinbelow with reference to Figs. 9 and 10.

More specifically, as shown in Fig. 10, the fixed terminal members 203 and the movable contact pieces 220 are connected to each other through a contact detecting device 281, which is connected to a central processing unit CPU which controls this system in a concentrated manner, while a position detecting device 283 of a jig (shown by an arrow in Fig. 10 for convenience of description) of a pressure inserting device 282 is connected to said central processing unit CPU. Thus, the central processing unit CPU produces a driving signal for driving said pressure inserting device 282 by receiving signals from said contact detecting device 281 and said position detecting device 283.

Now, when the movable contact 234 is out of contact with the fixed contact 221, the central processing unit CPU applies the driving signal to the pressure inserting device 282, which forces the

fixed terminal members 203 into the base 201 based on said signal, and the contact detecting device 281 detects the amount inserted under pressure so as to apply a detecting signal to the central processing unit CPU.

Thus, when the movable contacts 221 contact the fixed contacts 234, the contact detecting device 281 which detects this state applies the detecting signal to the central processing unit CPU, and based on said signal, the central processing unit CPU counts the detecting signal from the position detecting device 283. When the pressure inserting device 282 has forced the fixed terminal members into the holes 203 by a distance α , the central processing unit CPU stops the driving signal to the pressure inserting device 282, and thus, the adjustment of the contact pressure is completed.

According to the third embodiment, since the contact pressure is determined by the product of a spring constant of the movable contact pieces 220 and the amount α by pressure insertion, a predetermined contact pressure may be achieved if the fixed contact terminal members 203 are inserted under pressure by the predetermined amount. Particularly, according to the above embodiment, since the amount by the pressure insertion of the fixed terminal members 203 may be automatically subjected to fine adjustment by the pressure inserting device 282, there is an advantage that the contact pressure may be automatically adjusted.

The movable member 204 is made of a rectangular plate 241 of a magnetic material provided with the shaft portions 242 extending outwardly from the central side portions thereof. Between the shaft portions 242, a central shaft portion 243 is provided by an ejecting process, while in positions confronting each other, with the central shaft portion 243 held therebetween, insulating portions 244 are integrally formed by an outsert molding, with protrusions 245 being respectively formed on the under surface of the insulating portions 244.

The movable member 204 described above is pivotally supported through engagement of said shaft portions 242 with the recesses 214 of the support portions 213 on the base 201, and is arranged to depress the upper faces of the movable contact pieces 220 by the protrusions 245 thereof so as to deflect said contact pieces 220 in the arcuate shape (Fig. 8).

The electromagnet block 205 includes an iron core 251 formed by outwardly bending magnetic poles at opposite ends of a magnetic member having generally a U-shaped cross section, and a magnet 252 disposed at the central under surface of said iron core 251, which are subjected to an insert molding with a spool 253 made of an insulative resin.

It is to be noted here that the under surfaces of the magnet poles at the opposite ends of the iron core 251 may be exposed from the spool 253, or covered by the spool to a slight extent to provide a magnetic shielding effect.

The spool 253 includes flange portions 254 and 255 located at the opposite end magnetic pole portions of the iron core 251, and another flange portion 256 provided therebetween to hold a permanent magnet 252. Coil terminals 257 are attached to the flange portion 254 at one side in a state projecting upwardly and downwardly, while auxiliary terminals 258 are also attached to the flange portion 255 at the other end in a state also projecting upwardly and downwardly. Between the flange portions 254 and 256, and 255 and 256, a coil 259 is continuously wound, with lead wires thereof being electrically connected to the upper projecting portions of the coil terminals 257 referred to earlier. There are also provided engaging projections 257a and 258a.

Thus, the electromagnet block 205 has a magnetic pole portion 252a of the permanent magnet 252 thereof pressed against the central shaft portion 243 of the movable member 204 by inserting the coil terminals 257 and the auxiliary terminals 258 into the inserting holes 212 of the columns 211 on the base main body 210 for fixing.

The casing 206 has a rectangular box-like configuration capable of outwardly applying onto the base 201 provided with the electromagnet block 205, etc., and a junction between the casing 206 and the base 201 is sealed by filling a bonding agent 262 in a recess provided along the under surface outer edge of the base 201 for solidification. Thus, by fusing and sealing a hole 261 formed on casing 206 for closing, the assembling work is completed.

In the electromagnetic relay M3 having the construction as described above, for example, if the upper portion of the permanent magnet 242 is magnetized as N pole, and the lower portion thereof as S pole, a magnetic field is formed in a direction indicated by arrows (Fig. 8).

In the above state, when the current is caused to flow to the coil 259 through the coil terminals 257, thereby to magnetize, for example, the right side of the iron core 251 to the N pole and the left side thereof to the S pole as shown in Fig. 8, the attracting force at the right side magnetic pole portion of the iron core 251 becomes larger than that at the left side magnetic pole portion, and the movable member 204 rotates in the direction indicated by an arrow A about the central shaft portion 243.

Accordingly, the left side of the movable contact piece 220 urged by the protrusions 245 is further biased downwardly in Fig. 8, and the dis-

tance between the fixed contacts 234 and the movable contacts 221 located at the left side is increased, while as the protrusion 245 is displaced, the movable contacts 221 located at the right side contact the fixed contacts 234. Therefore, the fixed terminal members 203 at the right side are electrically connected to the movable terminal members 222, with the state being maintained even when the electric current is stopped.

On the other hand, when the direction of the current flowing through the coil 259 is changed over so as to magnetize the left side of the iron core 251 to N pole, and the right side thereof to S pole, the movable member 204 is rotated in the direction indicated by an arrow B, whereby the fixed contacts 234 and the movable contacts 221 at the right side in Fig. 8 are spaced from each other, while the fixed contacts 234 and the movable contacts 221 at the left side contact each other so that the fixed terminal members 203 and the movable terminal members 222 are electrically connected to each other, thereby returning to the original state.

Fourth embodiment

Reference is also made to Figs. 11 to 14 which shows an electromagnetic relay M4 according to a fourth embodiment of the present invention.

As shown in Figs. 11 and 12, the electromagnetic relay M4 similarly includes a base 301, two sets of movable terminal members 302, four sets of fixed terminal members 303, a movable member 304, an electromagnet block 305, and a casing 306.

The base 301 also in a rectangular plate-like configuration and made of an insulative synthetic resin has columns 311 extending upwardly from four corners on the upper surface of a base main body 310, while each of the columns 311 is formed with a terminal inserting bore 312 extending from its upper face to lower face. On the base 301, between the columns 311 along the longitudinal direction (i.e. in the direction indicated by arrows Y-Y'), support portions 313 with the recesses 314 are respectively provided, while, between the columns 311 and the support portions 313 along the direction of the short sides (i.e. in the direction of arrows X-X'), partition walls 315a and 315b are respectively provided, with accommodating portions 316 being formed at both sides of said partition walls 315a and 315b.

In the base main body 310, there are formed terminal inserting holes 317 at the base portions of the support portions 313, another sets of terminal inserting holes 318 between the columns 311 and the support portions 313, and recesses 319 at the base portions of the columns 311, while said termi-

nal inserting holes 318 are communicated with said recesses 319 by grooves 319a.

The movable terminal members 302 are constituted by movable contact pieces 320 and terminals 322. Each of the movable contact pieces 320 is made of a thin electrically conductive plate material, with movable contacts 321 being provided at opposite end upper faces. Meanwhile, each of the terminals 322 is folded at right angles at its upper portion to form a connecting portion 323, to which the movable contact pieces 320 are fixed each in an asymmetrical relation at the left and right sides, with one side being formed into a first movable contact piece 320a and the other side into a second movable contact piece 320b (Figs. 13 and 14).

The movable terminal members 302 each have the terminals 322 thereof extended onto the under surface of the base 301, with the first and second movable contact pieces 320a and 320b being respectively accommodated into accommodating portions 316.

Each of the fixed terminal members 303 is constituted by forming an arm portion 332 through extension of the upper portion of the terminal portion 331 laterally, and providing a contact base 333 by folding the upper portion of said arm portion 332 in the horizontal direction, with the lower end thereof being formed into a leg portion 335. There are also formed fixed contacts 334 on the under surface of said contact base 333.

When the fixed terminal members 303 are fixed by inserting the terminal portions 331 thereof into the holes 318 provided at the base portions of the columns 311, and the leg portions 335 into the recesses 319, with the arm portions 332 fitted into the groove portions 319a, the fixed contacts 334 confront the movable contacts 321.

The movable member 304 is made of a rectangular plate 341 of a magnetic material provided with shaft portions 342 extending outwardly from the central side portions thereof. Between the shaft portions 342, a protruding fulcrum portion 343 is provided by a press work from below, while in positions confronting each other, with the fulcrum portion 343 held therebetween, insulating portions 344 are integrally formed, with first and second protrusions or depressing portions 345 and 346 being respectively formed on the under surface of the insulating portions 344 in an asymmetrical relation with respect to said fulcrum portion 343.

Here, as shown in Figs. 13 and 14, a distance from the fulcrum portion 343 to the first protrusion 345 is represented by ℓ_1 , a distance to the second protrusion 346 therefrom is denoted by ℓ_2 , a reaction force of the first movable contact piece 320a by the depression of the respective protrusions 345 and 346 is shown by F_1 , and a reaction force of the second movable contact piece 320b thereby is

represented by F_2 . In this case, it is so arranged that when the electromagnetic relay M4 is used as a self-restoration type as shown in Fig. 13, i.e. in the case where the first movable contact piece 320a is depressed by the first protrusion 345, conditions represented by

$$F_1 \times \ell_1 > F_2 \times \ell_2$$

are satisfied, while as shown in Fig. 14, when the relay is used as a self-holding type, i.e. in the case where the mounting direction of said movable member 304 is altered so as to depress the second movable contact piece 320b by the first protrusion 345, and the first movable contact piece 320a by the second protrusion 346, conditions represented by

$$F_1 \times \ell_2 = F_2 \times \ell_1$$

are satisfied.

The movable member 304 described above is pivotally supported through engagement of said shaft portions 342 with recesses 314 of the support portions 313 on the base 301, and is arranged to depress the upper faces of the first and second movable contact pieces 320a and 320b by the first and second protrusions 345 and 346 so as to deflect the upper faces of said contact pieces 320a and 320b in the arcuate shape.

The electromagnet block 305 includes an iron core 351 formed by outwardly bending magnetic poles at opposite ends of a magnetic member having generally a U-shaped cross section, a magnet 352 disposed at the central under surface of said iron core 351, and a spool 353 made of an insulative resin and integrally mounted thereon in the similar manner as in the third embodiment.

It is to be noted here that the under surfaces of the magnet poles at the opposite ends of the iron core 351 may be exposed from the spool 353, or covered by the spool to a slight extent to provide a magnetic shielding effect.

The spool 353 includes flange portions 354 and 355 located at the opposite end magnetic pole portions of the iron core 351, and another flange portion 356 provided therebetween to hold a permanent magnet 352. Coil terminals 357 are attached to the flange portion 354 at one side in a state projecting upwardly and downwardly, while auxiliary terminals 358 are also attached to the flange portion 355 at the other end in a state also projecting upwardly and downwardly. Between the flange portions 354 and 356, and 355 and 356, a coil 359 is continuously wound, with lead wires thereof being electrically connected to the upper projecting portions of the coil terminals 357 referred to earlier.

Thus, the electromagnet block 305 has the under surface of the permanent magnet 352 thereof pressed against the fulcrum portion 343 of the movable member 304 by inserting the coil termi-

nals 357 and the auxiliary terminals 358 into the inserting bores 312 of the columns 311 on the base main body 310 for fixing.

The casing 305 has a rectangular box-like configuration capable of outwardly applying onto the base 301 provided with the electromagnet 305, etc., and a junction between the casing 306 and the base 301 is sealed by filling a bonding agent 371 in a recess provided along the under surface outer edge of the base 301 for solidification. Thus, by fusing and sealing a hole 361 formed on casing 306 for closing, the assembling work is completed in the similar manner as in the electromagnetic relay M3 in the third embodiment.

In the electromagnetic relay having the construction as described above, the relay may be used as the self-retaining type or self-restoring type according to the direction of mounting the movable member 304.

More specifically as shown in Fig. 13, when the relay is to be used as the self-holding type, since the setting is so made as to satisfy the conditions $F1 \times l1 > F2 \times l2$, the movable member 304 is rotated in the direction of the arrow B in Fig. 12, with the iron piece 341 of the movable member 304 at the left side being urged towards one end of the iron core 351. Thus, for example, if the upper portion of the magnet 352 is magnetized to the N pole, and the lower portion thereof, to the S pole as shown in Fig. 12, the magnetic field is formed in the direction indicated by arrows.

In the above state, when the current is caused to flow to the coil 359 through the coil terminals 357, thereby to magnetic, for example, the right side of the iron core 351 to the N pole and the left side thereof to the S pole as shown in Fig. 11, the attracting force at the right side magnetic pole portion of the iron core 351 with respect to the iron piece 341 becomes larger than that at the left side magnetic pole portion, and the movable member 304 rotates in the direction indicated by an arrow A about the fulcrum portion 343.

In the movable contact piece 320, the first movable piece 320a is urged downwardly by the first protrusion 345, and the distance between the fixed contacts 334 and the movable contacts 321 is increased, while as the second protrusion 346 is upwardly displaced, the second movable contact piece 320b is moved, and the movable contacts 321 are brought into contact with the fixed contacts 334. Therefore, the fixed terminal members 303 at the right side are electrically connected to the movable terminal members 302.

Meanwhile, for use as the self-holding type electromagnetic relay as shown in Fig. 14, the conditions represented by $F1 \times l2 = F2 \times l1$ are satisfied, with the movable member 304 being

well balanced at the left and right portions.

In this state, in the similar manner as in the relay of the self-restoring type, when the current is caused to flow to the coil 359 through the coil terminals 357, thereby to magnetize, for example, the right side of thereon core 351 to the N pole and the left side thereof to the S pole, the movable member 304 rotates in the direction indicated by an arrow A about the fulcrum portion 343.

Accordingly, the first movable contact piece 320a urged by the first protrusion 345 is further biased downwardly, and the distance between the fixed contacts 334 and the movable contacts 321 is increased, while as the second protrusion 346 is upwardly displaced, the movable contacts 321 contact the fixed contacts 334. Therefore, the fixed terminal members 303 at the right side are electrically connected to the movable terminal members 302.

On the other hand, when the direction of the current flowing through the coil 359 is changed over so as to magnetize the left side of the iron core 351 to N pole, and the right side thereof to S pole, the movable member 304 is rotated in the direction indicated by the arrow B, whereby the fixed contacts 334 and the movable contacts 321 as the right side are spaced from each other, while the fixed contacts 334 and the movable contacts 321 at the left side contact each other so that the fixed terminal members 303 and the movable terminal members 302 are electrically connected to each other.

It should be noted here that in the foregoing embodiment, although the present invention is mainly described as applied to the electromagnetic relay, the concept of the present invention is not limited to such relay alone, but may be readily applied to an electromagnetic switch or the like.

As is seen from the foregoing description, by the above embodiment of the present invention, electromagnetic relays of self-holding type and self-restoring type can be readily provided by merely changing the attaching direction of the movable member.

In other words, since the movable member can be constituted by the same part, the electromagnetic relays of the both type may be obtained without necessity for providing new processing steps (or facilities) as in the conventional arrangements.

Fifth embodiment

Referring further to Figs. 15 to 18, there is shown in Figs. 15 and 16, an electromagnetic relay M5 according to a fifth embodiment of the present invention.

It should be noted here that the relay M5 in this embodiment is approximately similar to the relay M4 of the fourth embodiment, and the main difference therebetween resides in that in the third embodiment, the contact pressure is adjusted by adjusting the amount of pressure insertion of the fixed contact terminal members, while in the present embodiment, the contact pressure is adjusted by adjusting the amount of pressure insertion of the electromagnet block.

More specifically, the base 401 has a fundamental construction generally similar to that in the third embodiment, and fixed terminal members 403 are formed by insert molding between the columns 411 facing the short side direction (i.e. X-X' direction), while fixed contacts 434 are respectively provided on contact bases 433 exposed upwardly. Moreover, with the intermediate point between support portions 413 provided on long side edges of the base 401 being set as a center point O_1 , at positions of point symmetry about the center point O_1 , connecting portions 423 of terminals 422 molded in the base 401 are respectively exposed.

There is provided a movable terminal member 402 which is constituted by the terminals 422 and a contact piece block 426 shown in Figs. 17 and 18, and this contact piece block 426 is formed by subjecting a pair of movable contact pieces 420 arranged in parallel to insert molding at central portions thereof by a block main body 424 of a synthetic resin material, with a pair of caulking projections 424a being provided on the upper surface of said block main body 424. The set of movable contact pieces 420 referred to above are plates of the same planner configuration produced by punching on electrically conductive thin plate, and each of the contact pieces 420 is divided into two parts at its opposite end portions so as to respectively provide movable contacts 421 on the under faces at the opposite ends, while hinge spring portions 426 having generally a J-shape in a flat plan are extended from the central portions of the long sides, with the connecting portions 425a at the free ends of said spring portions 425 being disposed at the positions of the point symmetry about the center point O_1 .

The movable member 404 of a flat plate-like configuration generally covering the contact piece block 426 has a shaft portion 446 at its central portion, and is formed with caulking holes 445a at opposed positions with respect to said shaft portion 446 held therebetween, and the central portion of said shaft portion 446 being set as a center axis portion 446b.

It is to be noted here that the movable member 404 may be replaced by another movable member prepared by punching a plate member from a magnetic material as in the third embodiment, and

provided with a shaft portion constituted by projections extended from the opposite sides, while an ejection processing is applied to the central portion to form the center axis portion.

The movable member 404 is formed into one unit with the contact piece 426 by fitting the caulking projections 424a of the contact piece block 426 into the holes 446a thereof for subsequent caulking.

It is needless to say that the processing for combining the contact piece block 426 with the movable member 404 is not limited to the caulking, but they may be combined into one unit, for example, by the insert molding to be effected two times.

Subsequently, opposite ends of the shaft portions 446 of the movable member 404 combined with the contact piece block 426 are respectively fitted into recesses 414 of the support members 413 provided on the base 401 for supporting by pivotal movement, and thereafter, connecting portions 425a of hinge spring portions 425 are respectively welded to the connecting portions 423 of the terminals 422 for electrical connection, whereby not only the movable member 404 is prevented from falling off, but the movable contacts 421 may respectively confront the fixed contacts 434 for selective contact and spacing.

According to the above embodiment, since the connecting portions 425a of the hinge spring portions 426 are not aligned on one side, but they are arranged in the point symmetry, there are such advantages that the spring force is not deviated to achieve favorable balancing, thereby facilitating the fine adjustment.

The electromagnet block 405 has an E-shaped cross section by attaching a permanent magnet 452 on an iron core 451 with a U-shaped cross section so as to be subjected to insert molding onto a spool 453. Since other construction is generally similar to that of the electromagnet block 305 described earlier with reference to the third embodiment, detailed description thereof is abbreviated here for brevity of explanation.

Thus, when the coil terminals 457 and the auxiliary terminals 458 are respectively force into the terminal inserting holes 412 provided in the base 401, the central axis portion 446b of the movable member 404 is pivotally attracted and supported by the magnetic pole portion 452a of the permanent magnet 452, while the opposite ends of the movable member 404 confront the opposite end magnetic poles of the iron core 451 for selective contact and spacing.

It is to be noted here that in the present embodiment, since positioning projections 457a (the positioning projection at the inner side is not shown) and 458a are respectively provided on the coil terminals 457 and auxiliary terminals 458, the

electromagnet block 405 may be inserted under pressure and fixed at any desired position.

Moreover, owing to the arrangement that the magnetic pole portion 452a of the permanent magnet 452 attracts and holds the center axis portion 446b of the movable member 404 for suspension, as the electromagnet block 405 is displaced upwardly or downwardly, the movable member 404 and the contact piece block 426 are moved in the similar manner following the above displacement. Therefore, if the amount of pressure insertion of the electromagnet block 405 is adjusted by the automatic adjusting system described earlier, the distance between the movable contact 421 of the movable contact piece 420 and the fixed contact 434 may be adjusted in the similar manner as explained previously, thus making it possible to effect the automatic adjustment of the contact pressure. The method of the adjustment is generally similar to that described with reference to the previous embodiment, and therefore, detailed description thereof is abbreviated here for brevity.

The casing 406 has a rectangular cubic box-like configuration which can be applied onto the base 401, and is formed with a gas discharging hole 461 at a corner on the top wall thereof.

The casing 406 is fitted onto the base 401 incorporated with the contact piece block 426, movable member 404 and electromagnet block 405, etc. with a sealing agent 462 is applied onto the bottom face of the base 401 for solidification and sealing, and thereafter, the gas inside the casing 406 is discharged from the gas discharging hole 461 for subsequent closing of said hole 461 by heat fusion, and thus, the assembly work of the relay is completed.

Hereinafter, functioning of the electromagnetic relay M5 having the construction described so far will be explained.

During de-energization, as shown in Fig. 19, the left side end portion 404a of the movable iron piece 404 is attracted to the left side magnetic pole 451a of the iron core 451 to close a magnetic circuit by a magnetic flux Φ of the contacts 421b of the movable contact piece 420 are held in contact with the fixed contacts 434b, while the movable contacts 421a are spaced from the fixed contacts 434a.

Subsequently, as shown in Fig. 20, upon application of a voltage to the coil 459 so as to generate a magnetic flux Φ_1 which cancels said magnetic flux Φ , the right side end portion 404b of the movable iron piece 404 is attracted to the right side magnetic pole 451b of the iron core 451, and therefore, the movable iron piece 404 is rotated about the center axis portion 446 as a fulcrum against the magnetic force of the permanent magnet 452, whereby the left side end portion 404a of

the movable iron piece 404 is spaced from the left side magnetic pole 451a of the iron core 451, and then, the right side end portion 404b of the movable iron piece 404 is attracted onto the right side magnetic pole 451b of the iron core 451. Accordingly, after the movable contacts 421b are spaced from the fixed contacts 434b following rotation of the movable iron piece 404, the movable contacts 421a are brought into contact with the fixed contacts 434a.

Thus, as shown in Fig. 21, even when the coil 459 is de-energized, the state is retained due to the magnetic flux Φ of the permanent magnet 452, without change-over of the contacts.

Thereafter, as shown in Fig. 22, upon energization by applying a voltage to the coil 459 so as to generate a magnetic flux Φ_2 which cancels the magnetic flux Φ of the permanent magnet 452, the movable iron piece 404 is rotated in the direction opposite to that in the previous function, thereby change-over the contacts for returning to the original state. The state is maintained even after the coil 459 is de-energized (Fig. 19).

According to the present embodiment as described so far, it is so arranged to open or close the contacts by directly driving the movable contact piece 420 through rotation of movable member 404, and the arrangement is different from that in the third embodiment in which the contacts are opened or closed by depressing the movable contact piece 320 by the protrusion 345 made of an insulating material and provided on the movable member. Therefore, such protrusions become unnecessary, and thus, no inconveniences take place due to variation of operating characteristics by abrasion of the protrusions or poor contacts arising from abraded powder of such protrusions, etc.

It should be noted that in the foregoing embodiment, although the electromagnetic relay has been mainly described with reference to the self-holding type, the concept of the present invention is not limited to such self-holding type alone, but may be readily applied to the relay of the self-restoring type as well.

According to the electromagnetic relay M5 of the present embodiment, since the desired contact pressure may be obtained by causing the movable contact piece 420 to deflect by a necessary minimum degree, spring load of the movable contact piece 420 is small as shown by a folded dotted line C in Fig. 23. Accordingly, owing to the fact that the contacts may be opened or closed by a small attracting force as shown by an attracting force dotted line D in Fig. 23, not only an electromagnetic relay of a high sensitivity can be obtained, but such a relay of a low electric consumption may also be presented.

Furthermore, even if the movable contacts

421a or 421b should be welded to the fixed contacts 434a or 434b, since the contact pressure is not added to the welding force as in the conventional arrangements, such welded portions may be easily separated forcibly through rotation of the movable iron piece 404, and thus, the undesirable welding may be advantageously prevented. Therefore, malfunctions of the electrical equipment due to contact fusing may be prevented in advance.

Moreover, according to the present invention, since it is so arranged to open or close the contacts by directly driving the movable contact piece through rotation of the movable iron piece 404, without depressing the movable contact piece by the protrusion provided on the movable iron piece for opening or closing the contacts, such a protrusion or the like becomes unnecessary, and thus, no inconvenience due to abrasion of the protrusion takes place.

Another advantage available by the arrangement of the present invention is such that, since the movable contact piece 420 is applied with the urging force only when the contacts are close, the movable contact piece 420 is not readily fatigued, and therefore, the material for the movable contact piece 420 may be selected from a wide range of materials.

It is to be noted here that in the foregoing embodiments, although the present invention has been described with reference to the electromagnetic relay of the self-holding type, the concept of the present invention is not limited in its application to the relay of the self-holding type alone, but may be readily applied to the relay of the self-restoring type as well. Additionally, the iron core having the U-shaped cross section described as employed in the electromagnet block for the above embodiment may, for example, be so modified as to improve magnetic efficiency by outwardly folding the magnetic pole portions at opposite ends of the iron core for increasing the attracting faces, or to be a self-restoring type through variation of a magnetic balance by outwardly folding only one of the magnetic pole portions.

Meanwhile, in one feature of the present invention, the electromagnet block is adapted to be forced into the base, and at the magnetic pole portion of the permanent magnet constituting said magnetic block, the movable member is pivotally attracted and held, with the movable contact piece being integrally provided at the under face of said movable member at a predetermined interval through the insulating member. Therefore, as the electromagnet block is vertically moved, the movable contact provided on the under surface of the movable contact piece is also vertically shifted, and thus, the distanced with respect to the fixed contact exposed from the upper surface of the base is

altered. As a result, the distance between the contacts and consequently, the contact pressure may be adjusted by displacing the electromagnet block vertically, and thus, adjustment of the contact pressure for the electromagnetic relay may be facilitated. Particularly, since the amount of pressure insertion can be finely adjusted by an adjusting mechanism, the electromagnet relay may be made still more compact in size.

As is clear from the foregoing description, according to the present invention, in order to obtain a desired contact pressure, since the contacts may be closed by causing said movable contact piece to be deflected by a minimum necessary amount, spring load for the movable contact piece may be reduced. Therefore, since the contacts may be opened or closed by a small attracting force, the electromagnetic relay not only highly sensitive, but low in power consumption may be obtained.

Moreover, since the movable contact piece is integrally provided at the under surface of the movable iron piece through the predetermined interval, the movable contact piece is driven following the pivotal movement of the movable iron piece. Therefore, the protruding portion as in the conventional arrangement becomes unnecessary, and the inconveniences such as variations of operating characteristics by the abrasion of the protruding portion or poor contact due to powder produced by abrasion do not take place.

Furthermore, according to the arrangement of the present invention, the fixed contact terminals are embedded in the base, with only the fixed contacts being exposed from the upper surface of the base, while no protruding portion or the like is required to be provided on the movable iron piece, and therefore, the height of the arrangement by the accumulation of the constituting parts may be reduced to provide a thin electromagnetic relay.

Additionally, since the movable contact piece is applied with the urging force only at the closing of the contacts, the movable contact piece is subjected to less fatigue than in the conventional arrangement, and thus, the material of the movable contact can be selected from a wide range of materials.

Even if the fusing phenomenon should take place between the movable contacts and the fixed contacts, since adhesion takes place only by the welding force, the contacts may be forcibly separated by only driving the movable contacts integrally formed with the movable contact piece, and thus, malfunctions due to contact fusion may be prevented.

On the other hand, according to the present invention, since the movable contact piece is located immediately below the movable iron piece, without protruding from the peripheral portion of

the movable iron piece, an electromagnetic relay having a small bottom area may be obtained.

Furthermore, according to another aspect to the present invention, the hinge spring portion of the movable contact piece is of a bent and substantially long shape, it is readily subjected to elastic deformation, requiring a small spring load. Therefore, no adverse effect is given to the pivotal function of the movable iron piece attracted and held by the magnetic pole portion of the permanent magnet, without deviation in the rotating point, not only a smooth open/close function is achieved, but the power consumption may be further saved.

Moreover, since the free ends of the hinge spring portions provided on the two movable contact pieces disposed in parallel, are arranged to be in a point symmetry, without aligning at one side, no deviation is produced in the spring force of the hinge spring portion, thus, providing a favorable balancing, and thus, fine adjustment of operating characteristics is facilitated, without requiring much time and labor for the adjusting work.

Although the present invention has been fully described by way of example with reference to the accompanying drawings, it is to be noted here that various changes and modifications will be apparent to those skilled in the art. Therefore, unless otherwise such changes and modifications depart from the scope of the present invention, they should be construed as included therein.

Claims

1. An electromagnetic relay which comprises a base, fixed contact terminals having fixed contacts, and movable contact terminals supporting intermediate portions of movable contact arms each provided, at opposite ends thereof, with movable contacts confronting said fixed contacts, said fixed contact terminals and said movable contact terminals being forced into said base to be fixed therein, an electromagnet block in which a coil is wound, through a spool, onto a core generally in an inverted U-shape provided with a permanent magnet at its central portion, and an armature block attracted and pivotally held by the permanent magnet so that opposite ends of said armature block confront pole faces of said core, said electromagnet block being assembled above said movable contact arms, thereby to allow the contacts to be closed through depression of said movable contact arms by said armature block.

2. An electromagnetic relay which comprises a base, movable contact terminals fixed to said base, movable contact arms each having movable contacts at its opposite ends and welded, at its central portion, to said movable contact terminals so as to

be supported thereby, fixed contact terminals each having fixed contacts contacting under pressure from above said movable contacts of said movable contact arms and forced into said base so as to be fixed, an electromagnet block in which a coil is wound through a spool, onto a core generally in an inverted U-shape provided with a permanent magnet at its central portion, and an armature block attracted and pivotally held by the permanent magnet so that opposite ends of said armature block confront pole faces of said core, said electromagnet block being assembled onto said base so as to be located above said movable contact arms, thereby to allow the contacts to be opened through depression of said movable contact arms by said armature block.

3. An electromagnetic relay which comprises a base provided, on its upper surface, with fixed contacts exposed upwardly, an electromagnet block constituted by an iron core of a generally U-shaped cross section provided with a permanent magnet to form a generally E-shaped cross section, with a coil being wound onto the iron core through a spool, and fixed above said base, a movable iron piece attracted and held, at its upper central portion, by a magnetic pole portion of said permanent magnet exposed to the under surface of said electromagnet block, and confronting at its opposite ends, magnetic pole portions at opposite ends of said iron core for selective contact with or spacing therefrom, and movable contact pieces each integrally connected, at central portions thereof, with under surface of said movable iron piece through an insulating member at a predetermined interval, with movable contacts provided on under surfaces at opposite ends of said movable contact pieces being arranged to confront the fixed contacts of said base for selective contact with or spacing therefrom.

4. An electromagnetic relay as claimed in Claim 3, wherein said movable contact pieces are positioned immediately below said movable iron piece so as not to protrude from peripheral portions of said movable iron piece.

5. An electromagnetic relay as claimed in Claim 3, wherein two pieces of said movable contact pieces disposed in parallel relation to each other respectively have long hinge spring portions bent to extend from central portions of their long sides so as to be in a point symmetry, with free ends of said hinge spring portions being welded to upper end of common terminals disposed on the upper surface of said base in a point symmetry.

6. An electromagnetic relay as claimed in Claim 4, wherein two pieces of said movable contact pieces disposed in parallel relation to each other respectively have long hinge spring portions bent to extend from central portions of their long

sides so as to be in a point symmetry, with free ends of said hinge spring portions being welded to upper end of common terminals disposed on the upper surface of said base in a point symmetry.

7. An electromagnetic relay which comprises a base, movable contact pieces horizontally disposed through a predetermined gap from an upper surface of said base, and having movable contacts provided on upper end faces thereof, and fixed terminal members each having generally an L-shape on its side face and provided with fixed contacts at under faces of horizontal portions thereof, said fixed terminal members being fixed, at terminal portions thereof, to said base, thereby to bring said fixed contacts into contact with said movable contacts for causing said movable contact pieces to curve in an arcuate shape, said terminal portions of said fixed terminal members being arranged to be forced into terminal inserting holes of said base from above.

8. An electromagnetic relay which comprises a movable member of an insulating material provided with first and second protrusions at opposite sides thereof, and first and second movable contact pieces disposed below said movable member and having movable contacts at opposite ends thereof so as to close or open said movable contacts through depression of said first or second movable contact piece by said protrusions based on rotation of said movable member, conditions represented by

$$F1 \times l1 > F2 \times l2$$

being satisfied when said first movable contact piece is depressed by said first protrusion, and said second movable contact piece is depressed by said second protrusion, wherein $l1$ is a distance from a rotational center of said movable member to said first protrusion, $l2$ is a distance therefrom to said second protrusion, $F1$ is a reaction force of said first movable contact piece (320a) with respect to the depression of said protrusions, and $F2$ is a reaction force of said second movable contact piece with respect thereto, and also, conditions represented by $F1 \times l2 = F2 \times l1$

being satisfied, when direction of attaching said movable member is altered so as to depress said second movable contact piece by said first protrusion, and said first movable contact piece, by said second protrusion.

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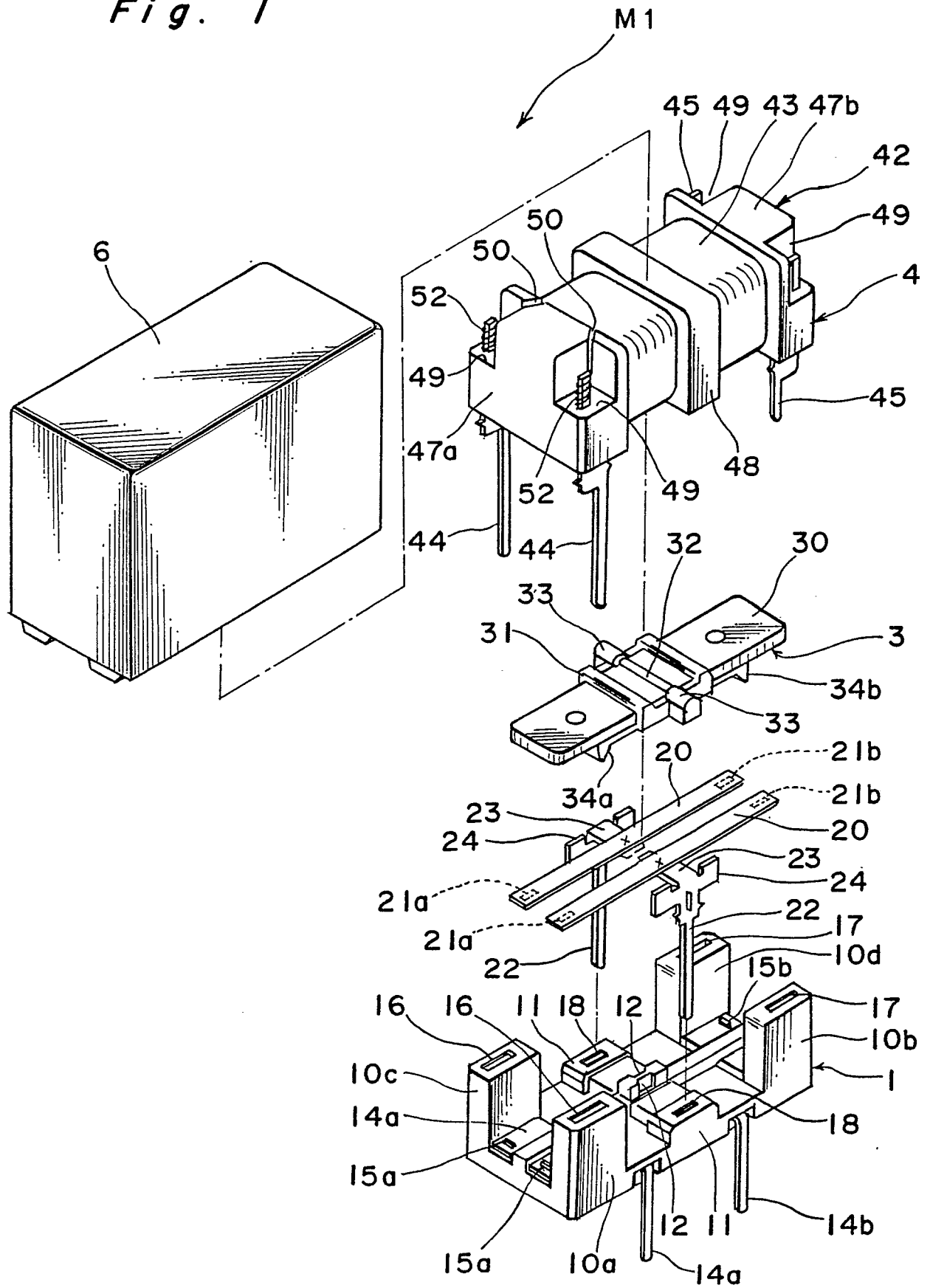
Fig. 1

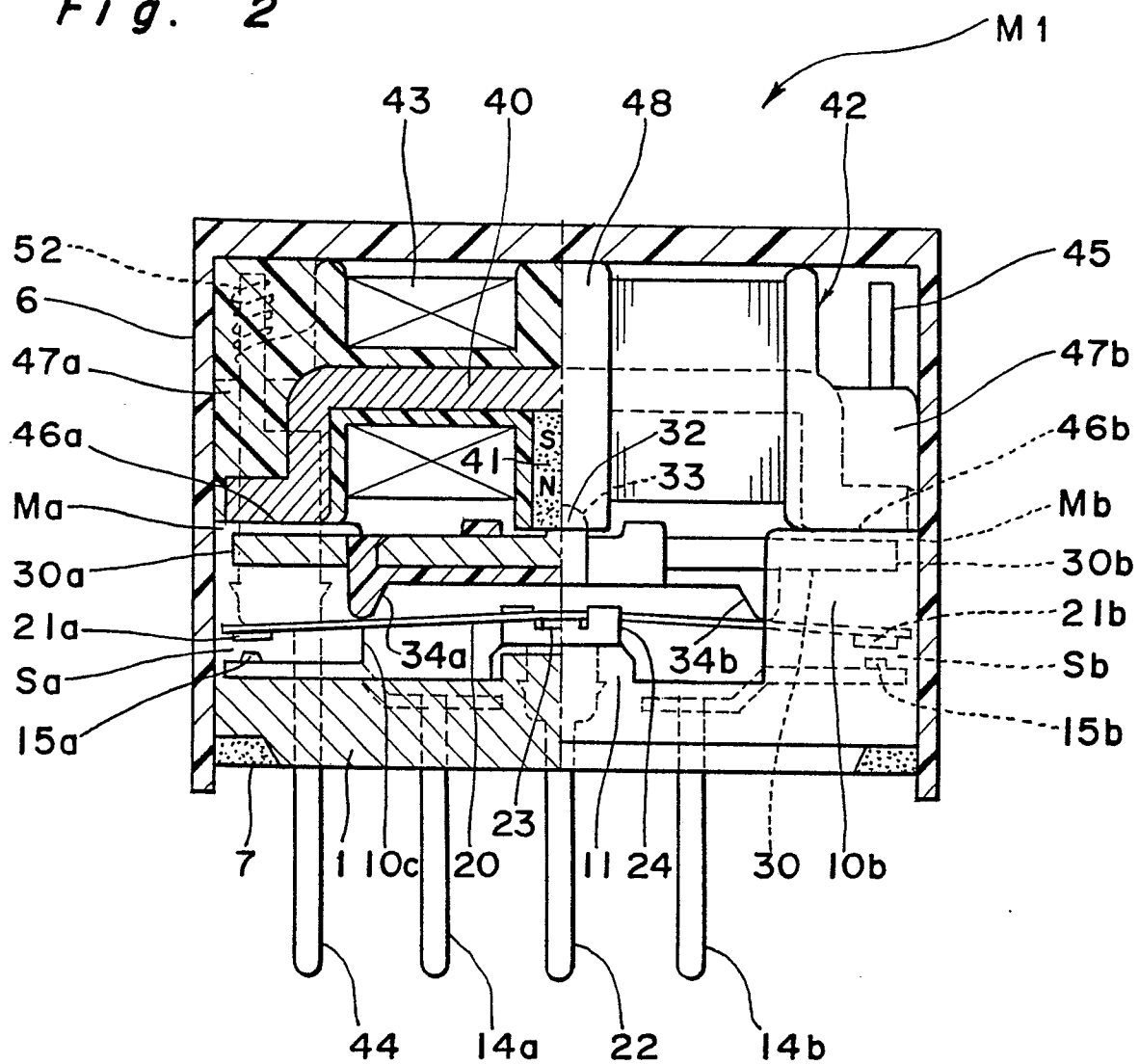
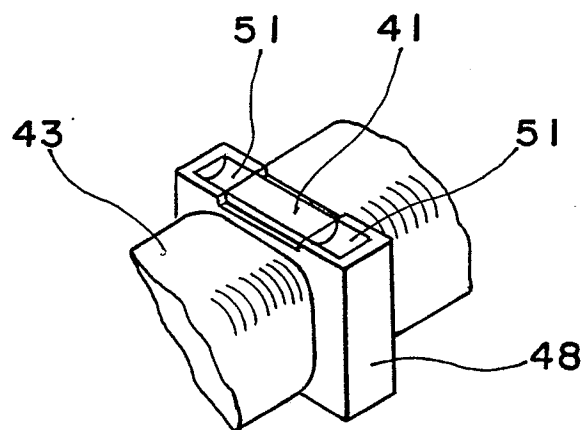
Fig. 2*Fig. 3*

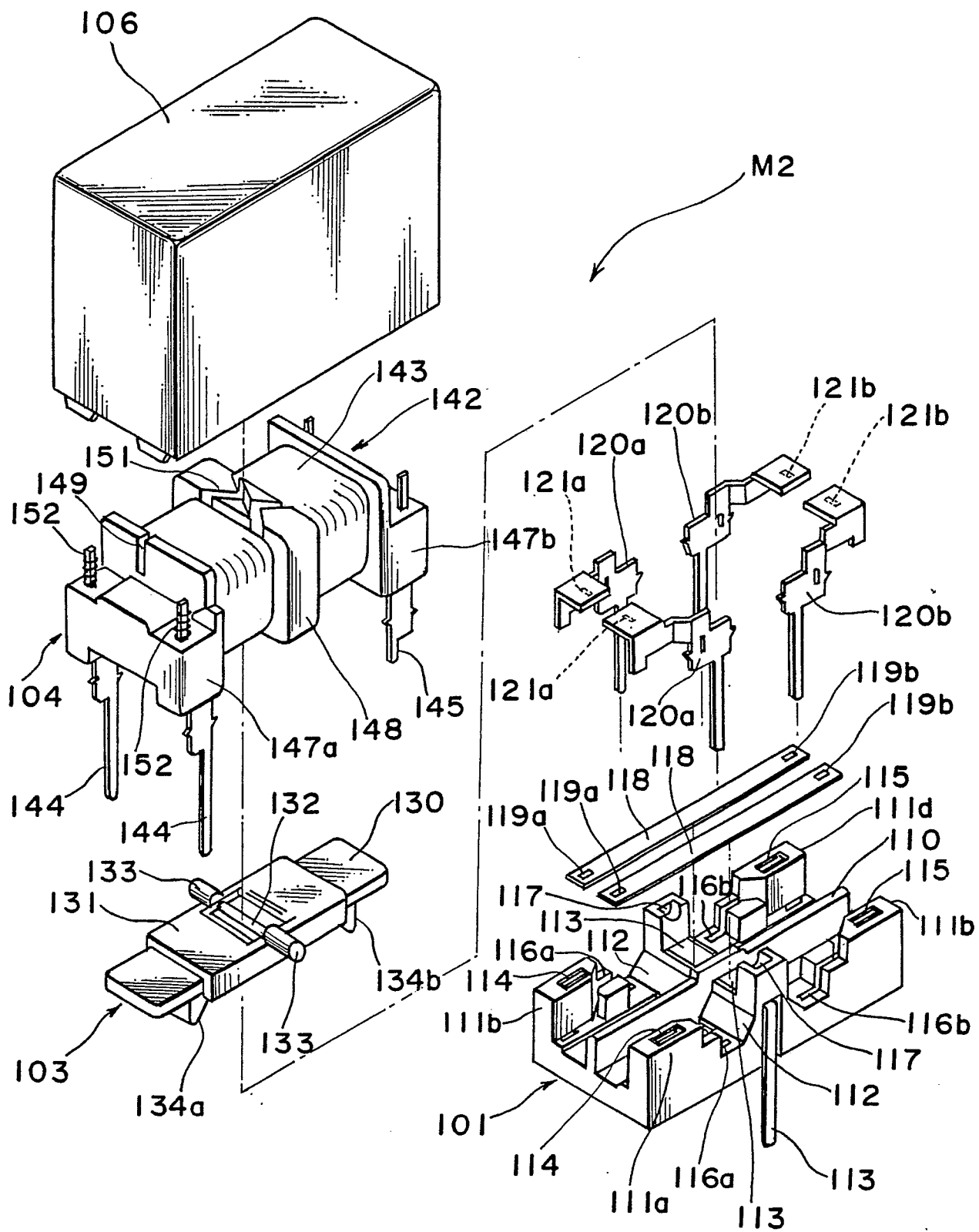
Fig. 4

Fig. 5

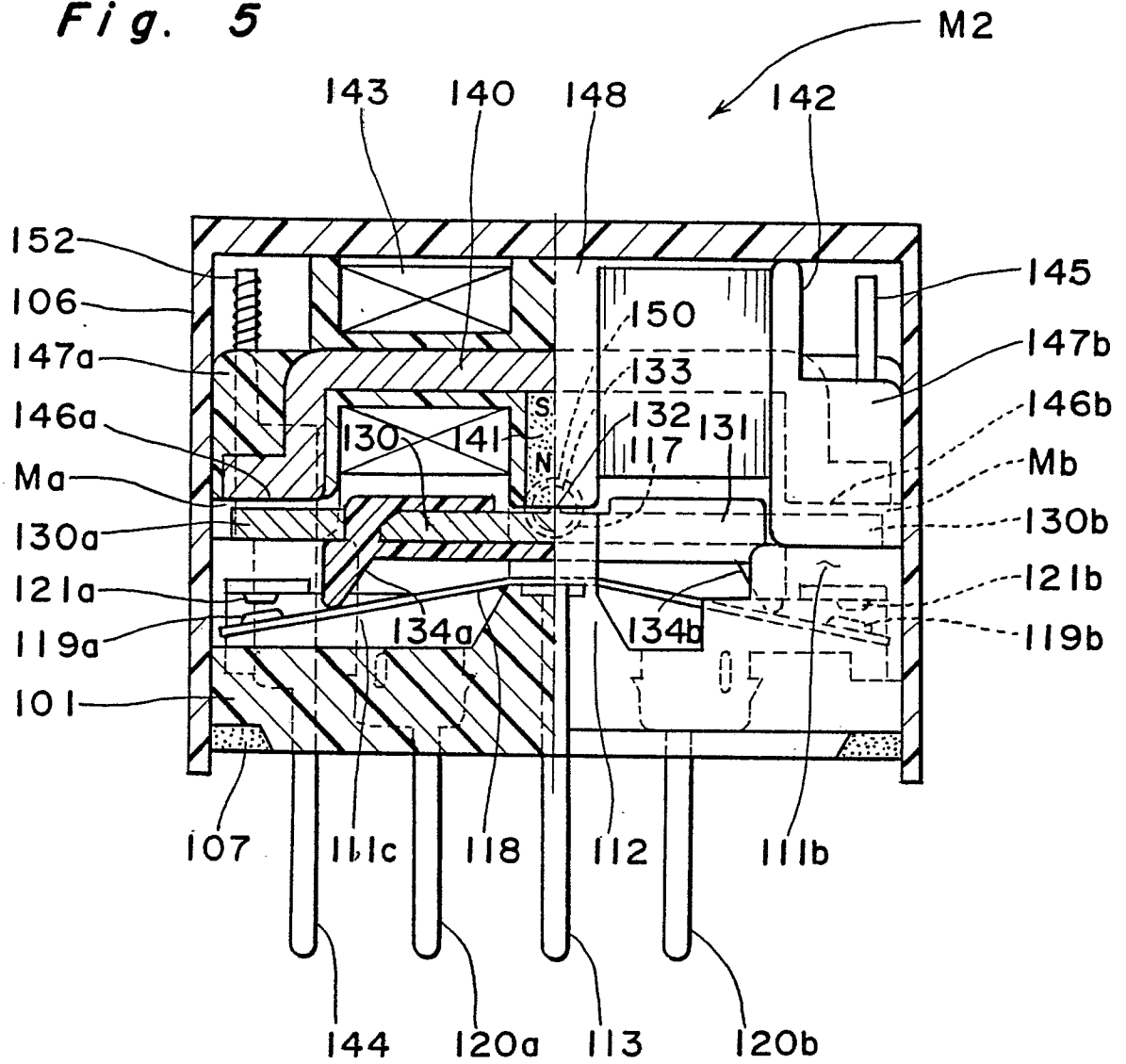


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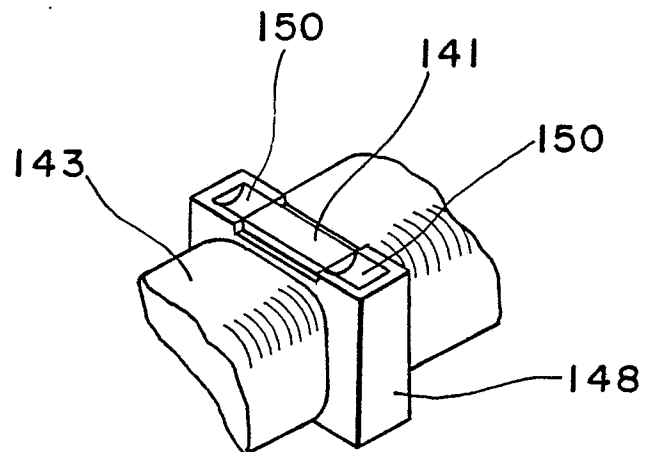


Fig. 7

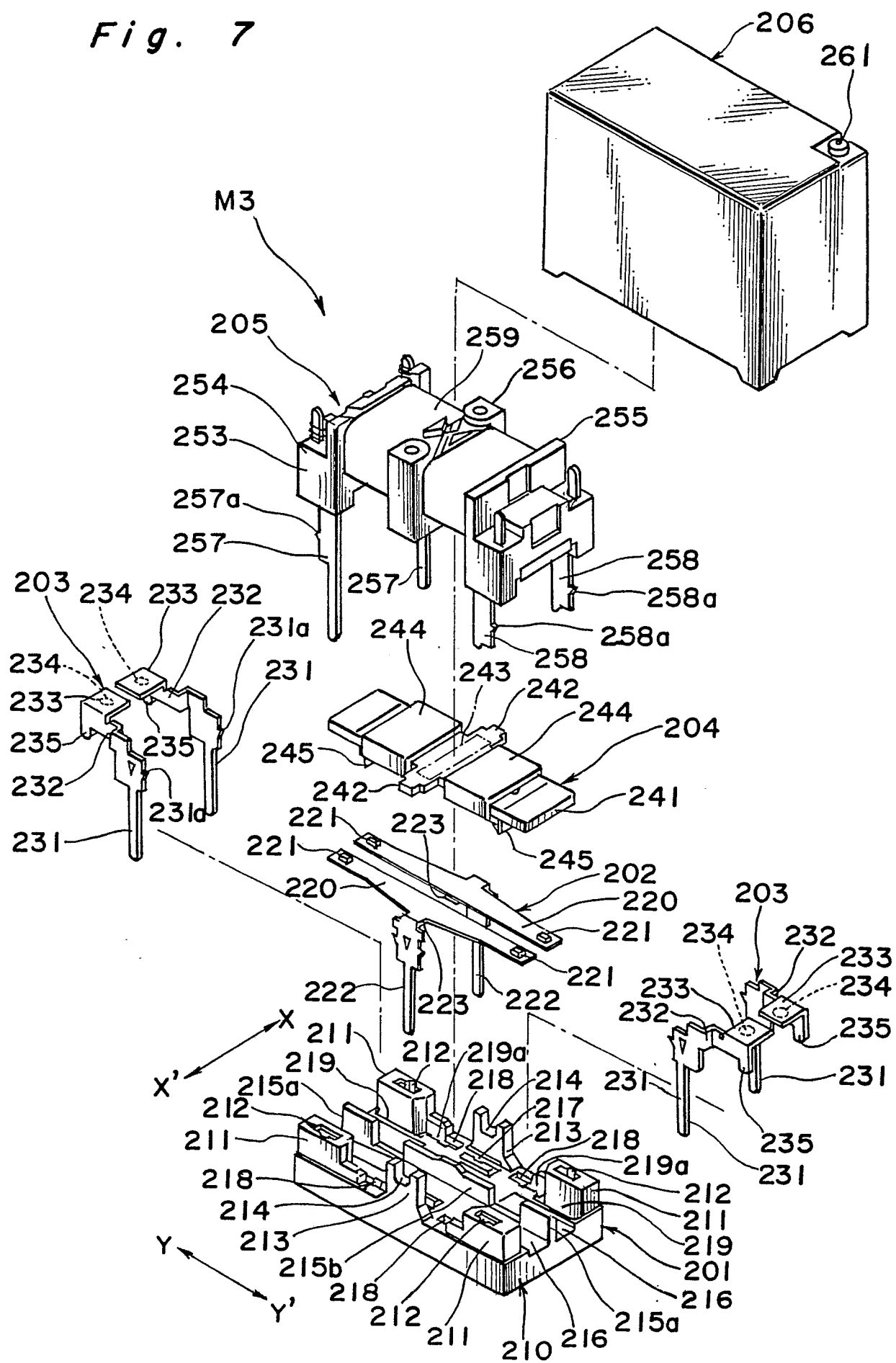


Fig. 8

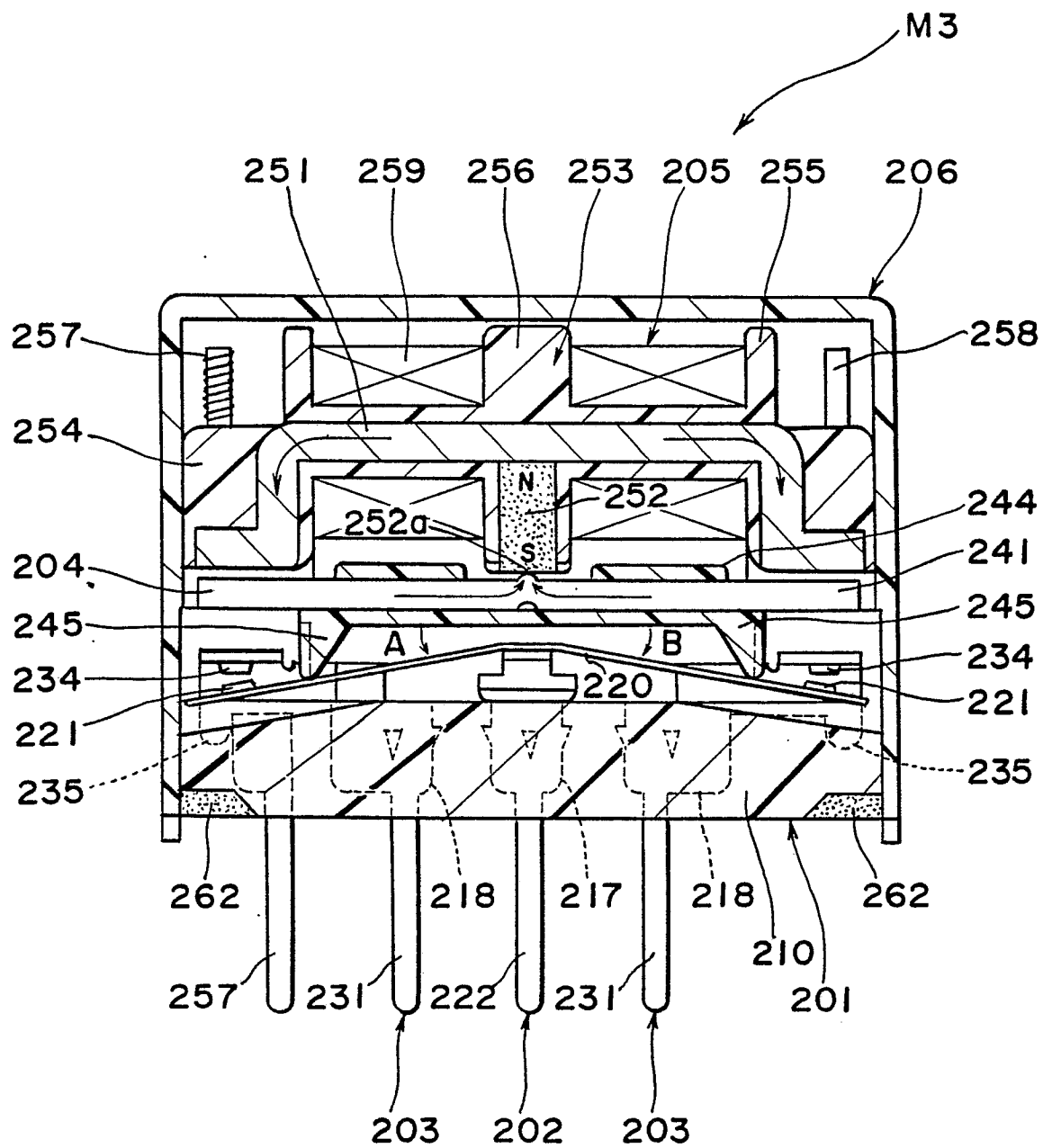


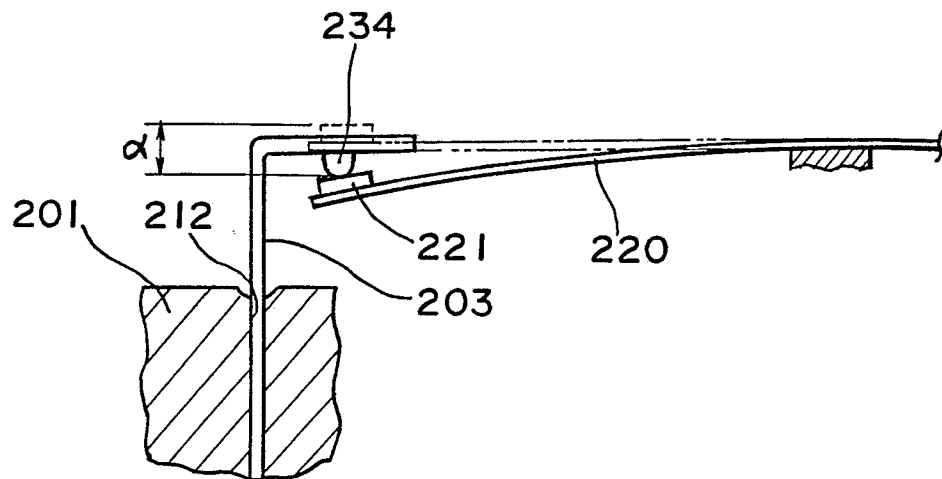
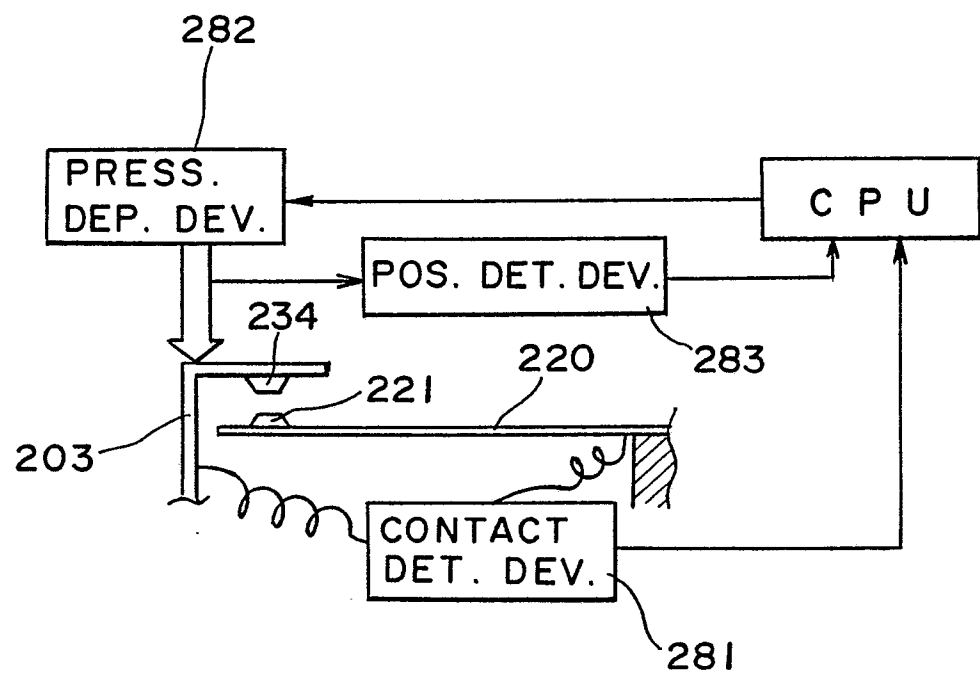
Fig. 9*Fig. 10*

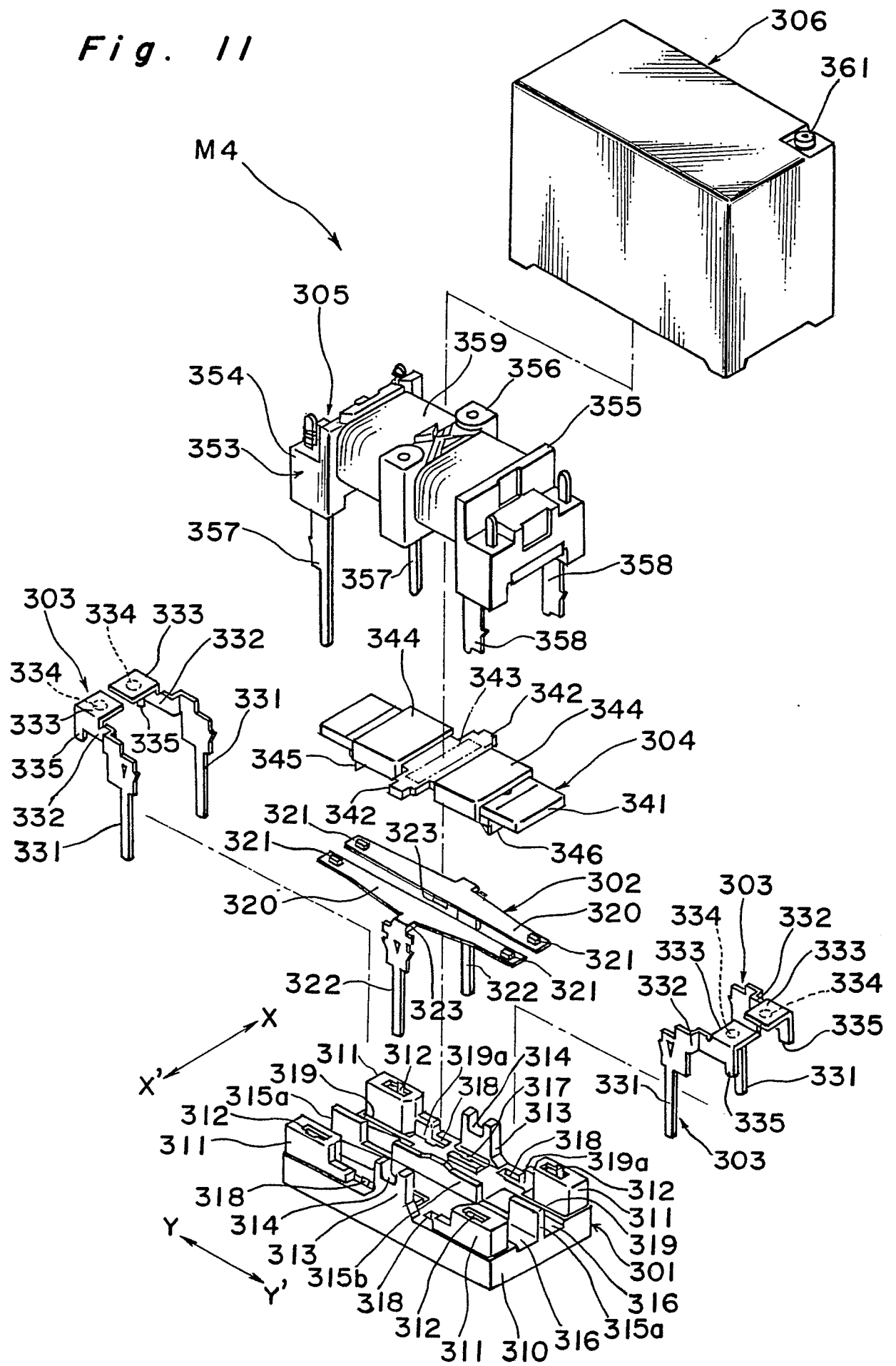
Fig. 11

Fig. 12

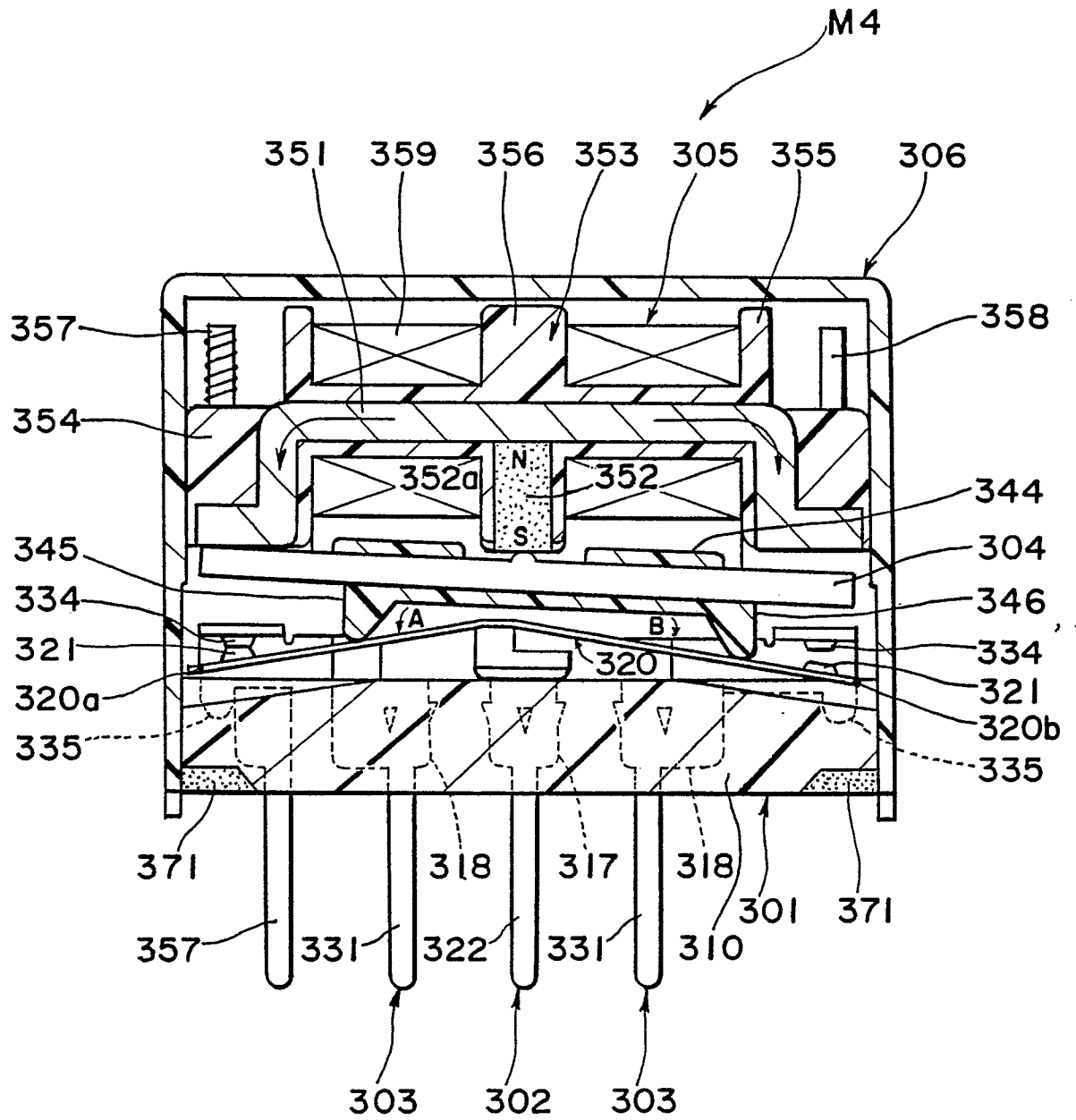


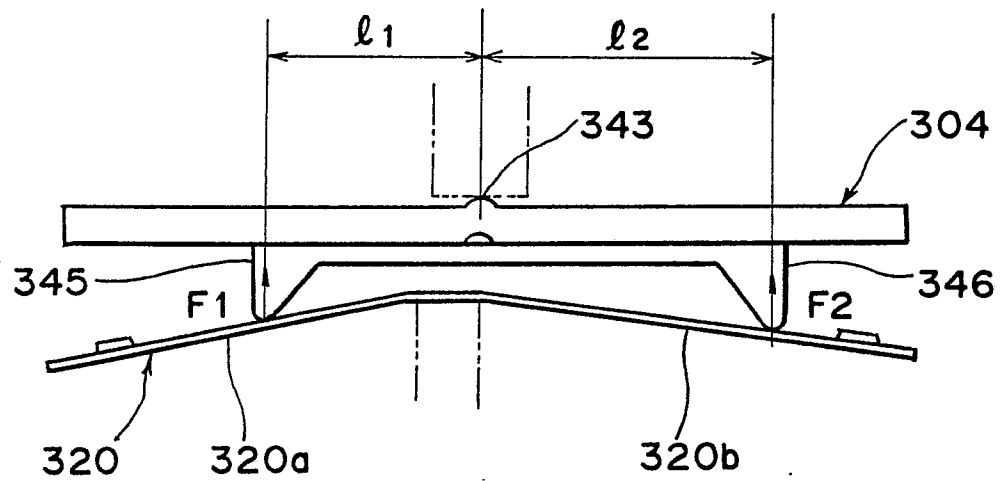
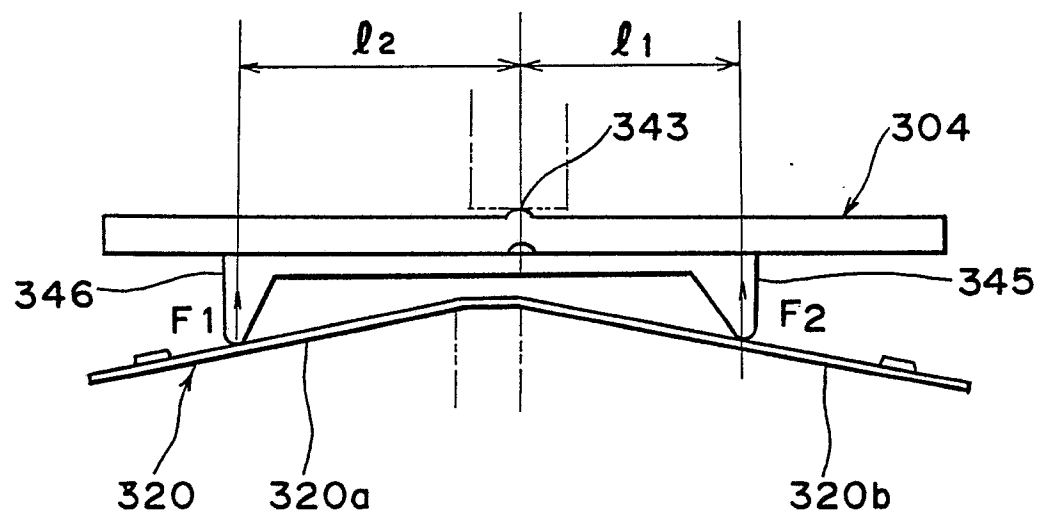
Fig. 13*Fig. 14*

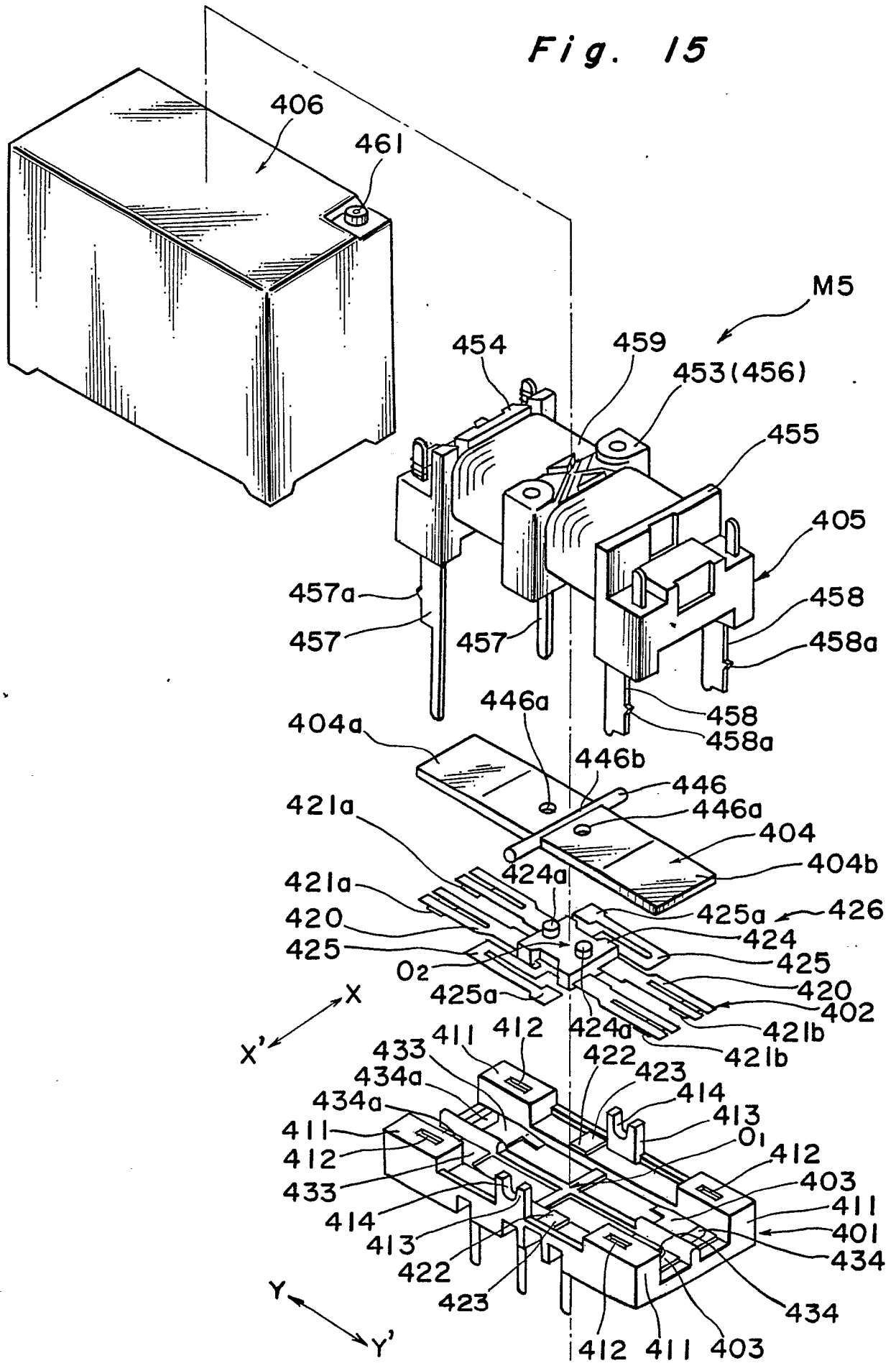
Fig. 15

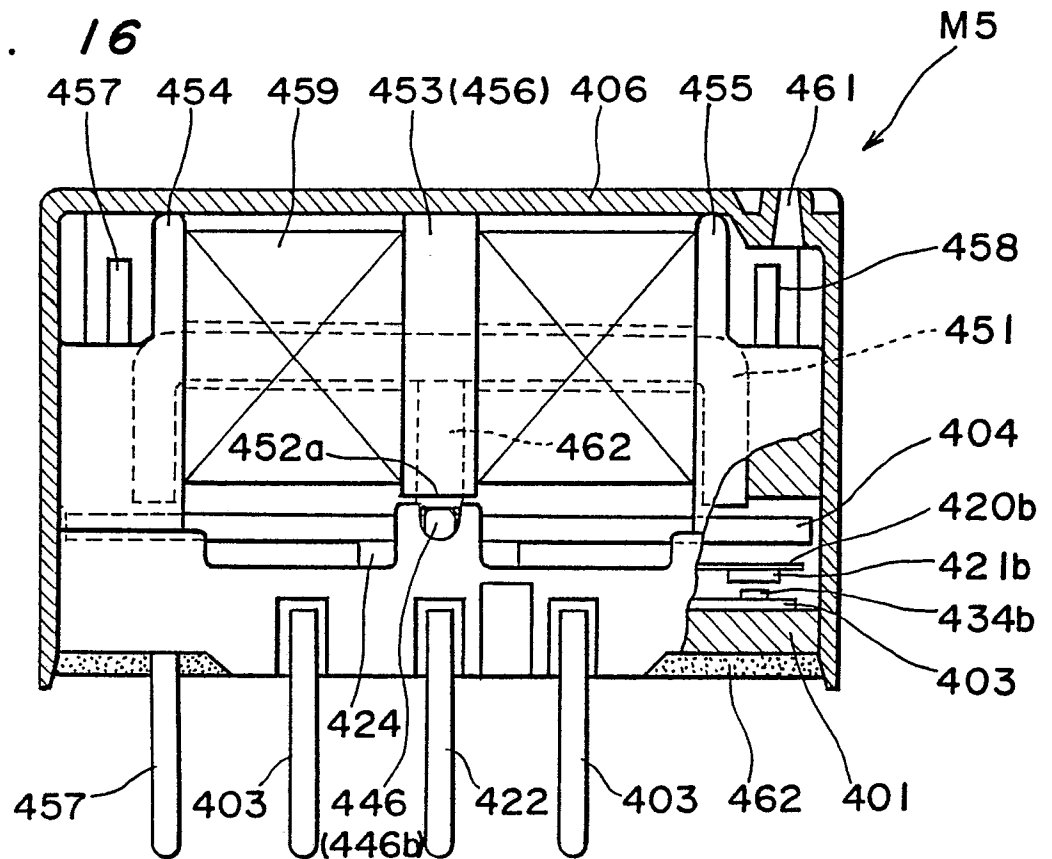
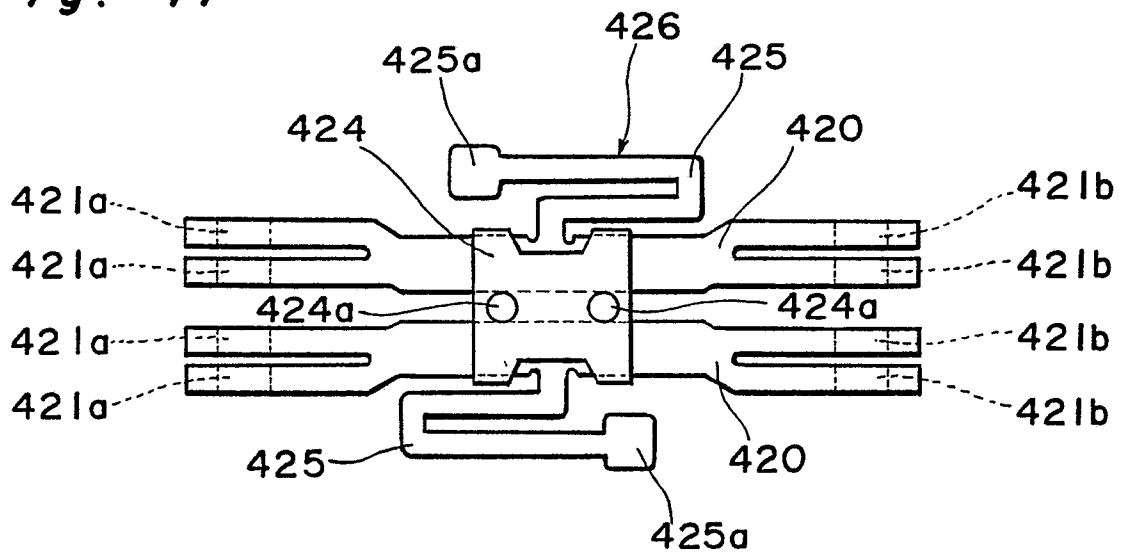
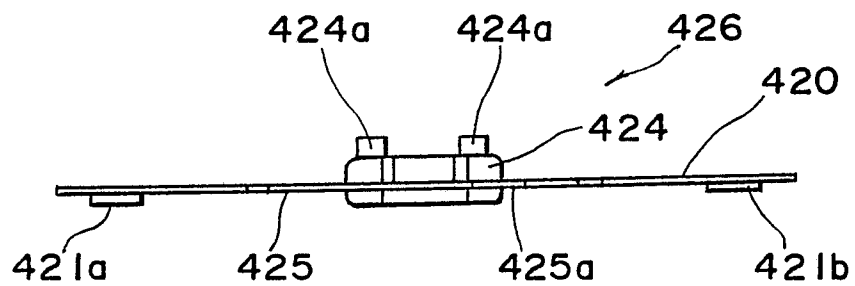
Fig. 16*Fig. 17**Fig. 18*

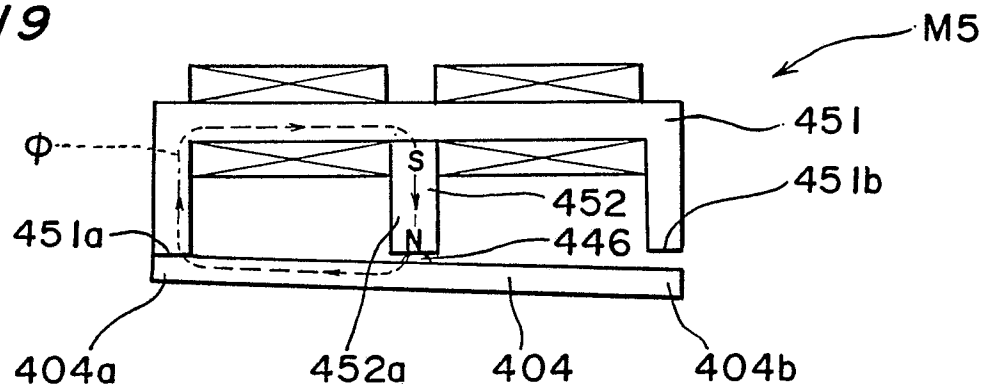
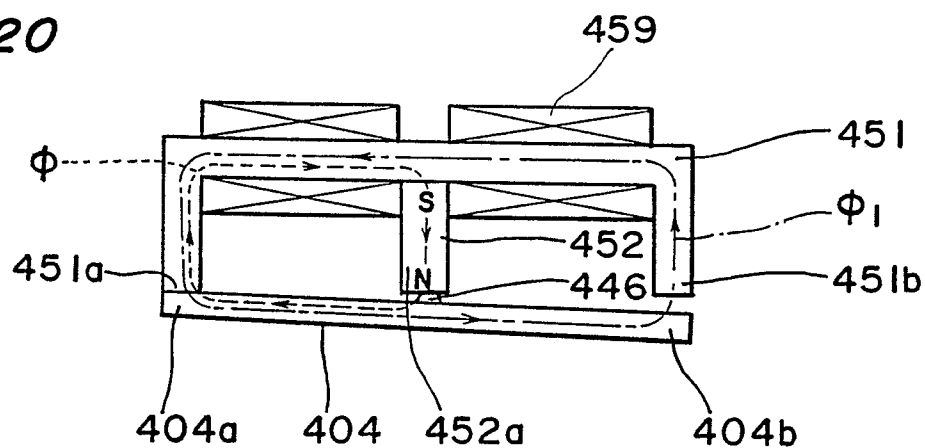
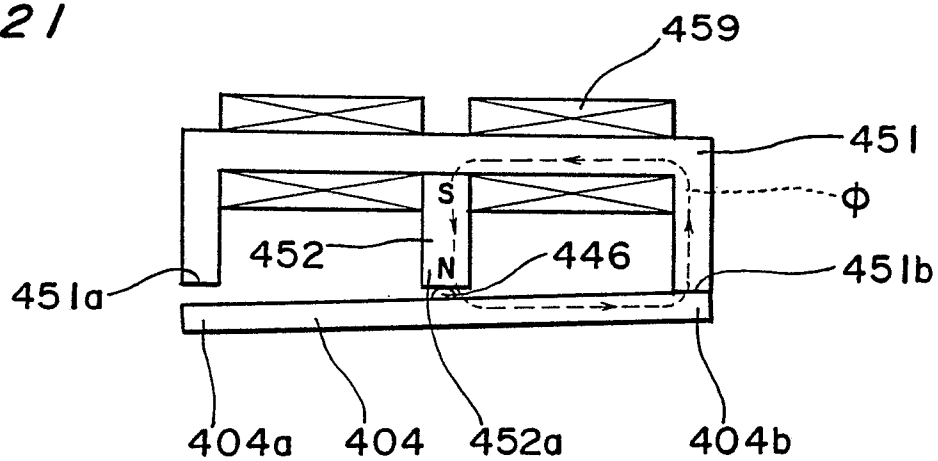
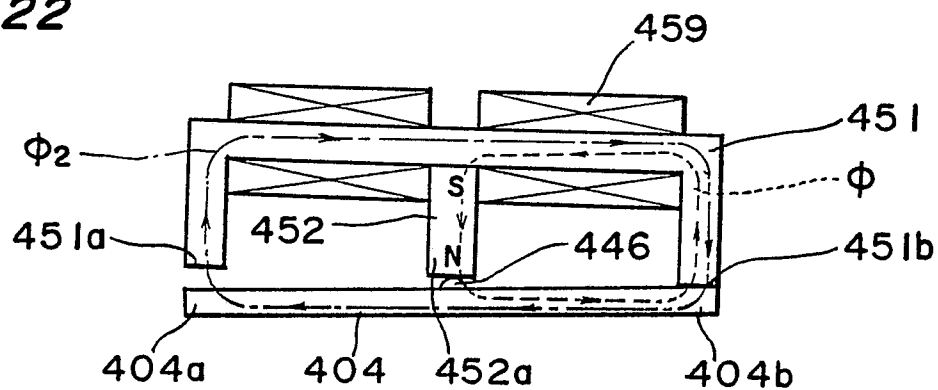
Fig. 19*Fig. 20**Fig. 21**Fig. 22*

Fig. 23

