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(54) **RELEASE-TYPE ELECTROMAGNET DEVICE AND PRODUCTION METHOD THEREFOR**

(57) In a release type electromagnetic device according to the present invention, a yoke in which a bobbin, an electromagnetic coil, a transfer yoke, and a permanent magnet are contained in an inner space is configured by arranging a plunger pass-through side yoke body which is located on the first bobbin frame body side of the bobbin and has a through hole communicated with a through hole of the bobbin, by arranging central side yoke bodies each of which is bent from the plunger pass-through side yoke body to the permanent magnet side, and by arranging permanent magnet side yoke bodies each of which is bent from each of the central side yoke bodies to the center side of the through hole of the bobbin to come into contact with the permanent magnet and to form a yoke closing portion at both end surfaces.

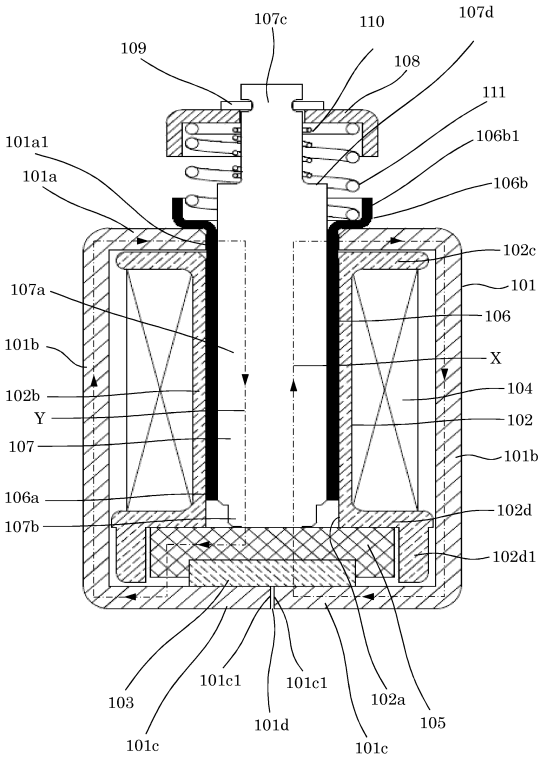

FIG. 1

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Description

[TECHNICAL FIELD]

[0001] The present invention relates to a release type electromagnetic device and a method of manufacturing the same, the device being used as a tripping device of a circuit breaker such as a molded case circuit breaker and an earth leakage circuit breaker.

[BACKGROUND ART]

[0002] As is well known, a circuit breaker such as a molded case circuit breaker and an earth leakage circuit breaker is configured such that when a short circuit, earth leakage, or the like occurs in a circuit connected to the circuit breaker, a tripping mechanism automatically trips to interrupt the aforementioned circuit based on a tripping signal generated by detecting the short circuit, earth leakage, or the like. Such a circuit breaker is provided with a release type electromagnetic device having an electromagnetic coil energized based on the tripping signal and a plunger that is released to move at the time of energizing the electromagnetic coil and the circuit breaker interrupts the circuit by tripping the tripping mechanism by the movement of the plunger of the release type electromagnetic device.

[0003] The release type electromagnetic device is composed of the electromagnetic coil, a yoke, a permanent magnet, the plunger, a release spring, and the like. The plunger is suctioned and retained to the yoke by the permanent magnet; however, at the same time, the release spring is biased in a direction of removing the suction. Normally, the suction force of the permanent magnet exceeds the biasing force of the release spring and thus the plunger is suctioned and retained. However, at the time of detecting the tripping signal, when current is supplied to the electromagnetic coil in polarities that weaken the magnetic force of the permanent magnet and the suction force is reduced than the biasing force of the release spring, the plunger is separated from the yoke by the force of the release spring to perform the tripping operation of the circuit breaker.

[0004] Heretofore, as release type electromagnetic devices used for circuit breakers, there is one, for example, disclosed in Patent Document 1 and Fig. 18. Patent Document 1 discloses a release type electromagnetic device in which an opening end of a main yoke is blocked by an end part yoke. The details of such a release type electromagnetic device will be described based on a sectional view of Fig. 18. In Fig. 18, a yoke 1 is composed of a bottom side yoke body 1a that retains a permanent magnet 2, a main yoke 1c which is bent from the bottom side yoke body 1a and has an opening end 1b, and an end part yoke 1d that blocks the opening end 1b of the main yoke 1c. After a permanent magnet 2, a transfer yoke 3, a bobbin 5 which is provided with a through hole 5b in a central portion 5a and in which an electromagnetic coil 4 is mounted on the outer peripheral surface of the central portion 5a between a first bobbin frame body 5c and a second bobbin frame body 5d, and a first insertion pipe 6 inserted in the through hole 5b of the bobbin 5 are contained in the bottom side yoke body 1a and the main yoke 1c, the opening end 1b of the main yoke 1c is blocked by the end part yoke 1d to constitute the yoke 1 composed of the end part yoke 1d, the main yoke 1c, and the bottom side yoke body 1a.

[0005] A cutout portion 5e is formed on the inner peripheral side of the second bobbin frame body 5d of the bobbin 5 and one side 6a of the first insertion pipe 6 is bent on the radially outer side and is engaged with the cutout portion 5e of the second bobbin frame body 5d of the bobbin 5 so that the first insertion pipe 6 is not slipped out from the bobbin 5. The other side 6b of the first insertion pipe 6 is arranged so as not to protrude on the axially outer side from the first bobbin frame body 5c of the bobbin 5.

[0006] A boss portion 1d2 having a through hole 1d1 whose diameter is the same diameter as or slightly larger than the inner diameter of the first insertion pipe 6 is provided in a central portion of the end part yoke 1d. A plunger 7 is inserted through the through hole 1d1 of the boss portion 1d2 of the end part yoke 1d and the inner peripheral side of the first insertion pipe 6 from one side 7a of the plunger 7; and a first insertion portion 7b of the plunger 7 is axially movable in the first insertion pipe 6.

[0007] A second insertion portion 7c of the plunger 7 is located in the through hole 1d1 of the boss portion 1d2 of the end part yoke 1d and its diameter is formed in a diameter smaller than the diameter of the first insertion portion 7b. The diameter of the other side 7d of the plunger 7 is formed in a diameter smaller than the diameter of the second insertion portion 7c; and a stepped portion 7e is formed between the other side 7d of the plunger 7 and the second insertion portion 7c of the plunger 7. A second insertion pipe 8 is fitted onto the outer peripheral surface of the second insertion portion 7c of the plunger 7 and is axially movable in the through hole 1d1 of the boss portion 1d2 of the end part yoke 1d.

[0008] One side 8a of the second insertion pipe 8 is located so as not to strike against the other side 6b of the first insertion pipe 6 when one side 7a of the plunger 7 comes into contact with the transfer yoke 3 by the suction force of the permanent magnet 2; and the other side 8b of the second insertion pipe 8 is bent on the outer peripheral surface side of the other side 7d of the plunger 7 so as to be along the stepped portion 7e formed between the other side 7d of the plunger 7 and the second insertion portion 7c of the plunger 7.

[0009] A plate 9 is arranged on the shaft end portion side of the other side 7d of the plunger 7 and is fixed by a fixing support body 10. The plate 9 is pressed by the spring force of a plate spring 11 fitted onto the other side 7d of the plunger 7 between the plate 9 and the other side 8b of the second insertion pipe 8 bent so as to be along the stepped portion 7e of the plunger 7 and is fixed

to the fixing support body 10.

[0010] A release spring 12 is arranged on the outer peripheral side of the boss portion 1d2 of the end part yoke 1d between the plate 9 and the end part yoke 1d of the yoke 1. The release spring 12 is arranged so that the biasing force that separates the plunger 7 from the transfer yoke 3 is maintained when one side 7a of the plunger 7 comes into contact with the transfer yoke 3 by the suction force of the permanent magnet 2.

[PRIOR ART DOCUMENT]

[PATENT DOCUMENT]

[0011] [Patent Document 1] Japanese Examined Patent Publication No. 5248982

[SUMMARY OF THE INVENTION]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

[0012] In the aforementioned conventional release type electromagnetic device, the yoke 1 is composed of two: the main yoke 1c; and the end part yoke 1d provided with the boss portion 1d2 having the through hole 1d1. Accordingly, there exist problems in that the number of components is increased; and when the main yoke 1c and the end part yoke 1d are joined by caulking or the like, control of magnetic resistance generated in a joint portion between the main yoke 1c and the end part yoke 1d is difficult and release characteristics are not stable.

[0013] Furthermore, the plunger 7 is configured in a three-stage diameter: the first insertion portion 7b, the second insertion portion 7c having the diameter smaller than the diameter of the first insertion portion 7b, and the other side 7d having the diameter smaller than the diameter of the second insertion portion 7c; and accordingly, a problem exists in that the plunger 7 is a complicated shape.

[0014] Besides, the pipe through which the plunger 7 is inserted is composed of two pipes: the first insertion pipe 6 inserted into the through hole 5b of the bobbin 5; and the second insertion pipe 8 fitted onto the outer peripheral surface of the second insertion portion 7c of the plunger 7. Accordingly, there exist problems in that the number of components is increased and there is provided a complicated shape having structure in which one side 6a of the first insertion pipe 6 is bent to the radially outer side to be brought into engagement with the cutout portion 5e formed in the second bobbin frame body 5d of the bobbin 5 and the first insertion pipe 6 is not slipped out from the bobbin 5.

[0015] As described above, the number of components is large and the shape is complicated; and accordingly, there exist problems in that much trouble and labor are required for such assembly work and much time is required for the assembly work.

[0016] Furthermore, positioning of the permanent magnet 2 and the transfer yoke 3 is performed by engaging the transfer yoke 3 in a protrusion portion 5f that slightly protrudes from the second bobbin frame body 5d of the bobbin 5 to the bottom side yoke body 1a side of the yoke 1. However, the protrusion portion 5f slightly protrudes to the bottom side yoke body 1a side of the yoke 1; and accordingly, a problem exists in that the positioning of the permanent magnet 2 and the transfer yoke 3 is far from being stably and reliably performed.

[0017] The present invention has been made to solve the problems described above, and an object of the present invention is to provide a release type electromagnetic device capable of obtaining stable release characteristics.

[0018] Furthermore, another object of the present invention is to provide a release type electromagnetic device capable of reducing the number of components to achieve simplification of assembly work.

[MEANS FOR SOLVING THE PROBLEMS]

[0019] According to the present invention, there is provided a release type electromagnetic device including: a bobbin in which a through hole is provided in a central portion, and an electromagnetic coil is mounted on the outer peripheral surface of the central portion between a first bobbin frame body and a second bobbin frame body; a transfer yoke arranged on the second bobbin frame body side of the bobbin; a permanent magnet arranged on the transfer yoke; a yoke in which the bobbin, the electromagnetic coil, the transfer yoke, and the permanent magnet are contained in an inner space; an insertion pipe inserted in the through hole of the bobbin; a plunger which is inserted in the inner periphery of the insertion pipe, and moves in a direction of coming into contact with or separating from the transfer yoke; and a release spring which biases the plunger in the direction of separating from the transfer yoke, the plunger being retained at a position coming into contact with the transfer yoke by the suction force of the permanent magnet, and being released in the direction of separating from the transfer yoke by the biasing force of the release spring when the electromagnetic coil is energized to reduce the suction force of the permanent magnet. In the release type electromagnetic device, the yoke is configured by arranging a plunger pass-through side yoke body which is located on the first bobbin frame body side of the bobbin and has a through hole communicated with the through hole of the bobbin, by arranging central side yoke bodies each of which is bent from the plunger pass-through side yoke body to the permanent magnet side, and by arranging permanent magnet side yoke bodies each of which is bent from each of the central side yoke bodies to the center side of the through hole of the bobbin to come into contact with the permanent magnet and to form a yoke closing portion at both end surfaces.

[0020] Furthermore, there is provided a method of manufacturing a release type electromagnetic device,

the method including the steps of: mounting an electromagnetic coil on the outer peripheral surface of a central portion between a first bobbin frame body and a second bobbin frame body of a bobbin provided with a through hole in the central portion; containing a transfer yoke and a permanent magnet in a surrounding portion provided in the second bobbin frame body of the bobbin; inserting an assembly body containing the transfer yoke and the permanent magnet in the surrounding portion of the second bobbin frame body of the bobbin into a yoke configured by arranging a plunger pass-through side yoke body which is located on the first bobbin frame body side of the bobbin and has a through hole communicated with the through hole of the bobbin, by arranging central side yoke bodies each of which is bent from the plunger pass-through side yoke body to the permanent magnet side, and by arranging permanent magnet side yoke bodies each of which is bent from each of the central side yoke bodies to the center side of the through hole of the bobbin to come into contact with the permanent magnet and to form a yoke closing portion at both end surfaces; inserting an insertion pipe from one side of the insertion pipe into the through hole of the plunger pass-through side yoke body of the yoke and the through hole of the bobbin until the other side of the insertion pipe comes into contact with the plunger pass-through side yoke body of the yoke; and arranging a release spring so as to have a predetermined biasing force between the other side of the insertion pipe and a plate by: fitting a plate spring onto the other side of the plunger, inserting an end portion of the other side of the plunger through a through hole of the plate, fitting the release spring onto the plunger after fixing the plate and the plate spring to the plunger by a fixing support body, and inserting the plunger from one side of the plunger through the insertion pipe until a pass-through portion of the plunger is inserted in the insertion pipe.

[ADVANTAGEOUS EFFECT OF THE INVENTION]

[0021] According to the release type electromagnetic device of the present invention, the yoke, in which the bobbin, the electromagnetic coil, the transfer yoke, and the permanent magnet are contained in the inner space, is configured by arranging the plunger pass-through side yoke body which is located on the first bobbin frame body side of the bobbin and has the through hole communicate with the through hole of the bobbin, by arranging the central side yoke bodies each of which is bent from the plunger pass-through side yoke body to the permanent magnet side, and by arranging the permanent magnet side yoke bodies each of which is bent from each of the central side yoke bodies to the center side of the through hole of the bobbin to come into contact with the permanent magnet and to form the yoke closing portion at both end surfaces, whereby there can be obtained a release type electromagnetic device capable of obtaining stable release characteristics.

[0022] Furthermore, there can be obtained a release type electromagnetic device capable of reducing the number of components to achieve simplification of assembly work.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0023]

Fig. 1 is a sectional view showing a release type electromagnetic device according to Embodiment 1 of the present invention;
Fig. 2 is an exploded development perspective view showing the release type electromagnetic device according to Embodiment 1 of the present invention;
Fig. 3 is a perspective view showing a yoke in the release type electromagnetic device according to Embodiment 1 of the present invention;
Fig. 4 is a perspective view showing a bobbin and an electromagnetic coil in the release type electromagnetic device according to Embodiment 1 of the present invention;
Fig. 5 is a perspective view showing a state where the bobbin and the electromagnetic coil are assembled, in the release type electromagnetic device according to Embodiment 1 of the present invention;
Fig. 6 is a perspective view showing an assembly body of the bobbin and the electromagnetic coil, a transfer yoke, and a permanent magnet in the release type electromagnetic device according to Embodiment 1 of the present invention;
Fig. 7 is a perspective view showing a state before an assembly body of the bobbin, the electromagnetic coil, the transfer yoke, and the permanent magnet is contained in the yoke, in the release type electromagnetic device according to Embodiment 1 of the present invention;
Fig. 8 is a perspective view showing a state where the assembly body of the bobbin, the electromagnetic coil, the transfer yoke, and the permanent magnet is contained in the yoke, in the release type electromagnetic device according to Embodiment 1 of the present invention;
Fig. 9 is a perspective view showing a state before an insertion pipe is contained in an assembly body of the bobbin, the electromagnetic coil, the transfer yoke, the permanent magnet, and the yoke, in the release type electromagnetic device according to Embodiment 1 of the present invention;
Fig. 10 is a perspective view showing a state where the insertion pipe is contained in the assembly body of the bobbin, the electromagnetic coil, the transfer yoke, the permanent magnet, and the yoke, in the release type electromagnetic device according to Embodiment 1 of the present invention;
Fig. 11 is a perspective view showing a state before a plunger is contained in an assembly body of the bobbin, the electromagnetic coil, the transfer yoke,

the permanent magnet, the yoke, and the insertion pipe, in the release type electromagnetic device according to Embodiment 1 of the present invention;

Fig. 12 is an exploded development perspective view of the plunger in the release type electromagnetic device according to Embodiment 1 of the present invention;

Fig. 13 is a perspective view showing the plunger and a fixing support body in the release type electromagnetic device according to Embodiment 1 of the present invention;

Fig. 14 is a perspective view showing a state where the plunger is contained in the assembly body of the bobbin, the electromagnetic coil, the transfer yoke, the permanent magnet, the yoke, and the insertion pipe, in the release type electromagnetic device according to Embodiment 1 of the present invention;

Fig. 15 is a perspective view showing a yoke in a release type electromagnetic device according to Embodiment 2 of the present invention;

Fig. 16 is a perspective view showing a yoke in a release type electromagnetic device according to Embodiment 3 of the present invention;

Fig. 17 is a perspective view showing a yoke in a release type electromagnetic device according to Embodiment 4 of the present invention; and

Fig. 18 is a sectional view showing a conventional release type electromagnetic device.

[MODE FOR CARRYING OUT THE INVENTION]

Embodiment 1.

[0024] Hereinafter, Embodiment 1 of the present invention will be described with reference to Fig. 1 to Fig. 14. Then, in each of the drawings, identical or equivalent members and portions will be described with the same reference numerals (and letters) assigned thereto. Fig. 1 is a sectional view showing a release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 2 is an exploded development perspective view showing the release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 3 is a perspective view showing a yoke in the release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 4 is a perspective view showing a bobbin and an electromagnetic coil in the release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 5 is a perspective view showing a state where the bobbin and the electromagnetic coil are assembled, in the release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 6 is a perspective view showing an assembly body of the bobbin and the electromagnetic coil, a transfer yoke, and a permanent magnet in the release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 7 is a perspective view showing a state before an assembly body of the bobbin, the electromagnetic coil, the transfer yoke, and the permanent magnet is contained in the yoke, in the release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 8 is a perspective view showing a state where the assembly body of the bobbin, the electromagnetic coil, the transfer yoke, and the permanent magnet is contained in the yoke, in the release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 9 is a perspective view showing a state before an insertion pipe is contained in an assembly body of the bobbin, the electromagnetic coil, the transfer yoke, the permanent magnet, and the yoke, in the release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 10 is a perspective view showing a state where the insertion pipe is contained in the assembly body of the bobbin, the electromagnetic coil, the transfer yoke, the permanent magnet, and the yoke, in the release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 11 is a perspective view showing a state before a plunger is contained in an assembly body of the bobbin, the electromagnetic coil, the transfer yoke, the permanent magnet, the yoke, and the insertion pipe, in the release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 12 is an exploded development perspective view of the plunger in the release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 13 is a perspective view showing the plunger and a fixing support body in the release type electromagnetic device according to Embodiment 1 of the present invention. Fig. 14 is a perspective view showing a state where the plunger is contained in the assembly body of the bobbin, the electromagnetic coil, the transfer yoke, the permanent magnet, the yoke, and the insertion pipe, in the release type electromagnetic device according to Embodiment 1 of the present invention.

[0025] In these respective drawings, a yoke 101 made of a magnetic material is configured by arranging a plunger pass-through side yoke body 101a which is located on the first bobbin frame body 102c side of a bobbin 102 and has a through hole 101a1, which is communicated with a through hole 102a formed in a central portion 102b of the bobbin 102 and is formed in a diameter substantially the same diameter as the through hole 102a, by arranging central side yoke bodies 101b each of which is bent from the plunger pass-through side yoke body 101a to the permanent magnet 103 side, and by arranging permanent magnet side yoke bodies 101c each of which is bent from each of the central side yoke bodies 101b to the center side of the through hole 102a of the bobbin 102 to come into contact with the permanent magnet and to form a yoke closing portion 101d at both end surfaces 101c1. More specifically, the yoke 101 is configured by bending a single plate into a rectangular shape to form the yoke closing portion 101d at the position of both end surfaces 101c1 of the permanent magnet side yoke bodies 101c that come into contact with the perma-

nent magnet 103. There is shown a case where the yoke closing portion 101d is provided in a direction orthogonal to the axial direction of a plunger 107 (to be described later), for example, provided linearly.

[0026] An electromagnetic coil 104 is mounted on the outer peripheral surface of the central portion 102b between the first bobbin frame body 102c of the bobbin 102 and the second bobbin frame body 102d of the bobbin 102. A surrounding portion 102d1 extended with a slight gap against the permanent magnet side yoke bodies 101c is provided in the second bobbin frame body 102d of the bobbin 102; positioning is performed by containing a transfer yoke 105 made of a magnetic material in the surrounding portion 102d1; and positioning of the permanent magnet 103 positioned on the transfer yoke 105 is also performed in the surrounding portion 102d1 by positioning the transfer yoke 105.

[0027] An insertion pipe 106 made of a non-magnetic material is inserted through the through hole 101a1 of the plunger pass-through side yoke body 101a of the yoke 101 and the through hole 102a of the bobbin 102. One side 106a of the insertion pipe 106 is extended until a position not coming into contact with the transfer yoke 105; and the other side 106b of the insertion pipe 106 forms a receiving seat 106b1 which is extended on the radially outer side from the through hole 101a1 of the plunger pass-through side yoke body 101a on the outside of the plunger pass-through side yoke body 101a and receives a release spring 111 (to be described later). One side 106a, the other side 106b, and the receiving seat 106b1 are formed in one constitutional body.

[0028] An insertion portion 107a of the plunger 107 is inserted in the inner periphery of the insertion pipe 106; the plunger 107 moves in a direction of coming into contact with or separating from the transfer yoke 105 in the insertion pipe 106; and one side 107b of the plunger 107 comes into contact with or separates from the transfer yoke 105. The other side 107c of the plunger 107, which has a diameter smaller than a diameter of the insertion portion 107a, is arranged at a position where the insertion portion 107a of the plunger 107 is located on the outside of the plunger pass-through side yoke body 101a; and a stepped portion 107d is formed between the insertion portion 107a of the plunger 107 and the other side 107c of the plunger 107.

[0029] A plate 108 is arranged on the shaft end portion side of the other side 107c of the plunger 107 and is fixed by a fixing support body 109. The plate 108 is pressed by the spring force of a plate spring 110 fitted onto the other side 107c of the plunger 107 between the plate 108 and the stepped portion 107d of the plunger 107 and is fixed to the fixing support body 109.

[0030] The release spring 111 is arranged between the plate 108 and the receiving seat 106b1 of the other side 106b of the insertion pipe 106 on the outer peripheral side of the insertion portion 107a of the plunger 107, which is located on the outside of the plunger pass-through side yoke body 101a. The release spring 111 is arranged so as to maintain biasing force that separates the plunger 107 from the transfer yoke 105 when one side 107b of the plunger 107 comes into contact with the transfer yoke 105 by the suction force of the permanent magnet 103.

[0031] Next, the operation of the thus configured release type electromagnetic device of the present invention will be described. Fig. 1 shows a state in which the plunger 107 is arranged at a reset position by the reset operation of a circuit breaker (not shown in the drawing). At this time, as shown in a magnetic flux path X, magnetic flux of the permanent magnet 103 returns from an N-pole to an S-pole via the transfer yoke 105; the plunger 107; the insertion pipe 106; and the plunger pass-through side yoke body 101a, the central side yoke body 101b, and the permanent magnet side yoke body 101c of the yoke 101. If the suction force of the permanent magnet 103 is set to Fm and the biasing force of the release spring 111 is set to Fs, the plunger 107 is suctioned to the transfer yoke 105 by a force of "Fm-Fs." More specifically, Fig. 1 shows the state in which one side 107b of the plunger 107 comes into contact with the transfer yoke 105 by the suction force of the permanent magnet 103 and the magnetic flux circuit X by the permanent magnet 103 is formed. The suction force of the permanent magnet 103 is a larger suction force than the biasing force of the release spring 111 and the plunger 107 is suctioned and retained to the transfer yoke 105 by the suction force of the permanent magnet 103.

[0032] When the circuit breaker (not shown in the drawing) detects a short circuit and/or earth leakage and the electromagnetic coil 104 is energized based on a tripping signal, the magnetic flux returns to the plunger 107 via the plunger 107; the transfer yoke 105; the permanent magnet side yoke body 101c, the central side yoke body 101b, and the plunger pass-through side yoke body 101a of the yoke 101; and the insertion pipe 106, as shown by a magnetic flux circuit Y. As described above, the magnetic flux is generated so as to cancel the suction force of the permanent magnet 103. Then, when the suction force Fm of the permanent magnet 103 is smaller than the biasing force Fs of the release spring 111, the plunger 107 is separated from the transfer yoke 105 by the biasing force Fs of the release spring 111 to be protruded and moved to the outer upper side of the plunger pass-through side yoke body 101a of the yoke 101 on the paper surface of Fig. 1 and a tripping mechanism (not shown in the drawing) trips the circuit.

[0033] The release type electromagnetic device in this Embodiment 1 solves the problem in which, as described in the above conventional release type electromagnetic device, since the yoke 1 is composed of two: the main yoke 1c; and the end part yoke 1d provided with the boss portion 1d2 having the through hole 1d1, the control of magnetic resistance generated in the joint portion between the main yoke 1c and the end part yoke 1d is difficult and the release characteristics are not stable.

[0034] The yoke 101 in this Embodiment 1 is config-

ured by bending the single plate into the rectangular shape and is configured by arranging the plunger pass-through side yoke body 101a which is located on the first bobbin frame body 102c side of the bobbin 102 and has the through hole 101a1 which is communicated with the through hole 102a formed in the central portion 102b of the bobbin 102 and is formed in the diameter substantially the same diameter as the through hole 102a, by arranging the central side yoke bodies 101b each of which is bent from the plunger pass-through side yoke body 101a to the permanent magnet 103 side, and by arranging the permanent magnet side yoke bodies 101c each of which is bent from each of the central side yoke bodies 101b to the center side of the through hole 102a of the bobbin 102 to come into contact with the permanent magnet and to form the yoke closing portion 101d at both end surfaces 101c1. More specifically, the yoke 101 is configured by bending the single plate into the rectangular shape to form the yoke closing portion 101d at the position of both end surfaces 101c1 of the permanent magnet side yoke bodies 101c that come into contact with the permanent magnet 103. Thus, a plated film thickness and/or an air gap generated at the aforementioned conventional joint portion is eliminated and magnetic flux fluctuations can be remarkably reduced; and therefore, stable release characteristics can be secured.

[0035] Furthermore, the plunger 107 is not configured in the three-stage diameter of the first insertion portion 7b, the second insertion portion 7c having the diameter smaller than the diameter of the first insertion portion 7b, and the other side 7d having the diameter smaller than the diameter of the second insertion portion 7c, as described in the above conventional one; but the plunger 107 is configured in a two-stage diameter of the insertion portion 107a and the other side 107c and a simple shape can be achieved.

[0036] Furthermore, the insertion pipe 106 is inserted through the through hole 101a1 of the plunger pass-through side yoke body 101a of the yoke 101 and the through hole 102a of the bobbin 102. One side 106a of the insertion pipe 106 is extended until the position not coming into contact with the transfer yoke 105, one side 106a being not processed at all; and the other side 106b of the insertion pipe 106 forms a receiving seat 106b1 which is extended on the radially outer side from the through hole 101a1 of the plunger pass-through side yoke body 101a on the outside of the plunger pass-through side yoke body 101a and receives a release spring 111. One side 106a, the other side 106b, and the receiving seat 106b1 are formed in one constitutional body. Therefore, the insertion pipe 106 is not one which is composed of two pipes: the first insertion pipe 6 inserted into the through hole 5b of the bobbin 5; and the second insertion pipe 8 fitted onto the outer peripheral surface of the second insertion portion 7c of the plunger 7, as described in the above conventional one. Then, the insertion pipe 106 is not a complicated shape having the structure in which one side 6a of the first insertion pipe 6 is bent to the radially outer side to be brought into engagement with the cutout portion 5e formed in the second bobbin frame body 5d of the bobbin 5 and the first insertion pipe 6 is not slipped out from the bobbin 5. However, the insertion pipe 106 can be formed in one constitutional body having the simple structure; and therefore, the number of components can be reduced to achieve simple assembly.

[0037] Moreover, the insertion pipe 106 is inserted through the through hole 101a1 of the plunger pass-through side yoke body 101a of the yoke 101 and the through hole 102a of the bobbin 102; and thus, positional deviations of the yoke 101 and the bobbin 102 can be suppressed.

[0038] Additionally, the insertion pipe 106 is made of the non-magnetic material and secures a magnetic gap between the yoke 101 and the plunger 107; and therefore, the insertion pipe 106 has function as a plunger guide.

[0039] In addition, as for fixing the insertion pipe 106, the other side 106b of the insertion pipe 106 is provided with the receiving seat 106b1, which is extended on the radially outer side from the through hole 101a1 of the plunger pass-through side yoke body 101a on the outside of the plunger pass-through side yoke body 101a and receives the release spring 111. Then, the position of the insertion pipe 106 is set by being pressed to the plunger pass-through side yoke body 101a of the yoke 101 by the biasing force of the release spring 111; and therefore, work such as adhesion is not required and simplification of assembly work can be achieved.

[0040] As described above, the number of components can be reduced to achieve a simple shape; and therefore, much trouble and labor are not required for such assembly work, simple assembly work can be performed, and assembly work can be performed simply and in a short time.

[0041] Besides, as for the positioning of the permanent magnet 103 and the transfer yoke 105, the surrounding portion 102d1 extended with the slight gap against the permanent magnet side yoke bodies 101c is provided in the second bobbin frame body 102d of the bobbin 102 and the transfer yoke 105 made of the magnetic material and the permanent magnet 103 positioned on the transfer yoke 105 are merely contained in the surrounding portion 102d1, whereby the positioning can be stably and reliably performed.

[0042] Next, the procedure for assembling the release type electromagnetic device in the aforementioned Embodiment 1 will be described. Fig. 2 shows the exploded development perspective view of the entire release type electromagnetic device. Fig. 3 is the perspective view showing the yoke 101 in Embodiment 1. The yoke 101 is configured by bending the single plate into the rectangular shape; and the yoke 101 is composed of the plunger pass-through side yoke body 101a having the through hole 101a1, the central side yoke bodies 101b each of which is bent from the plunger pass-through side yoke

body 101a to the permanent magnet 103 side, and the permanent magnet side yoke bodies 101c each of which is bent to the center side to come into contact with the permanent magnet and to form the yoke closing portion 101d at both end surfaces 101c1.

[0043] As described above, since the yoke 101 is formed by bending the single plate into the rectangular shape, the number of components can be reduced, magnetic resistance does not exist because of no joint portion, and the release characteristics can be stabilized; as compared to one which is composed of the main yoke 1c having the opening end 1b bent from the bottom side yoke body 1a and the end part yoke 1d that blocks the opening end 1b of the main yoke 1c, as described in the above conventional one.

[0044] First, as shown in Fig. 5, the electromagnetic coil 104 is mounted on the outer peripheral surface of the central portion 102b between the first bobbin frame body 102c of the bobbin 102 and the second bobbin frame body 102d of the bobbin 102. As shown in Fig. 6, the transfer yoke 105 is contained in the surrounding portion 102d1 to perform positioning of the transfer yoke 105, the surrounding portion 102d1 being provided in the second bobbin frame body 102d of the bobbin 102 on which the electromagnetic coil 104 is mounted; and the permanent magnet 103 is attached to an concaved portion of the transfer yoke 105 to perform positioning. The transfer yoke 105 and the permanent magnet 103 are merely contained in the surrounding portion 102d1 provided in the second bobbin frame body 102d of the bobbin 102, whereby the positioning can be stably, reliably, and simply performed. Furthermore, the transfer yoke 105 is retained in the surrounding portion 102d1 of the second bobbin frame body 102d of the bobbin 102 by mounting screws 112.

[0045] As described above, the surrounding portion 102d1 in which the whole of the transfer yoke 105 and the permanent magnet 103 are contained is provided in the second bobbin frame body 102d of the bobbin 102, whereby the positioning of the transfer yoke 105 and the permanent magnet 103 can be stably, simply, and reliably performed. Furthermore, the cutout portion 5e which is described in the above conventional one, is not formed on the through hole 102a side of the second bobbin frame body 102d of the bobbin 102, thereby providing a simple structure.

[0046] Next, as shown in Fig. 7 and Fig. 8, an assembly body in which the transfer yoke 105 and the permanent magnet 103 are contained in the surrounding portion 102d1 provided in the second bobbin frame body 102d of the bobbin 102 is inserted into a space of the yoke 101 from an opening portion of the yoke 101 until a position where the through hole 102a of the bobbin 102 corresponds to the through hole 101a1 of the plunger pass-through side yoke body 101a of the yoke 101.

[0047] As described above, the cutout portion 5e which is described in the above conventional one, is not formed on the through hole 102a side of the second bobbin frame body 102d of the bobbin 102. Therefore, such a configuration is not the complicated shape in which one side 6a of the first insertion pipe 6 is bent on the radially outer side to be brought into engagement with the cutout portion 5e formed in the second bobbin frame body 5d of the bobbin 5 and the first insertion pipe 6 is not slipped out from the bobbin 5 as described in the above conventional one; but the configuration is a significantly simple structure and assembling performance is also simple.

[0048] Further, as shown in Fig. 9 and Fig. 10, the insertion pipe 106 is sequentially inserted into the through hole 101a1 of the plunger pass-through side yoke body 101a of the yoke 101 and the through hole 102a of the bobbin 102 from one side 106a of the insertion pipe 106 from the outside of the plunger pass-through side yoke body 101a of the yoke 101, so that the other side 106b extended to the radially outer side of the insertion pipe 106 is brought into contact with the plunger pass-through side yoke body 101a of the yoke 101.

[0049] As described above, since one insertion pipe 106 is merely inserted into the through hole 101a1 of the plunger pass-through side yoke body 101a of the yoke 101 and the through hole 102a of the bobbin 102 from one side 106a of the insertion pipe 106 until the other side 106b of the insertion pipe 106 comes into contact with the plunger pass-through side yoke body 101a of the yoke 101, the number of components can be reduced and simple configuration can be provided; as compared to one which is composed of two pipes: the first insertion pipe 6 inserted into the through hole 5b of the bobbin 5; and the second insertion pipe 8 fitted onto the outer peripheral surface of the second insertion portion 7c of the plunger 7, as described in the above conventional one.

[0050] Furthermore, in this Embodiment 1, since one insertion pipe 106 is merely inserted until the other side 106b of the insertion pipe 106 comes into contact with the plunger pass-through side yoke body 101a of the yoke 101, significantly simple insertion work can be achieved; as compared to one which is complicated in structure in which the first insertion pipe 6 is fixed by being inserted through the through hole 5b of the bobbin 5 and fitting of the second insertion pipe 8 onto the outer peripheral surface of the second insertion portion 7c of the plunger 7 is also complicated, as described in the above conventional one. Incidentally, one side 106a of the insertion pipe 106 is not bent to the radially outer side as described in the above conventional one, but one side 106a merely faces the transfer yoke 105 with a predetermined distance and any processing is not applied, thereby providing simple structure.

[0051] Then, as shown from Fig. 11 to Fig. 14, the plate spring 110 is fitted onto the other side 107c of the plunger 107; an end portion of the other side 107c of the plunger 107 is inserted through the through hole 108a of the plate 108; the release spring 111 is fitted onto the plunger 107 after fixing the plate 108 and the plate spring 110 to the plunger 107 by the fixing support body 109; and the plunger 107 is inserted through the insertion pipe 106

from one side 107b of the plunger 107 until the insertion portion 107a of the plunger 107 is inserted in the insertion pipe 106, whereby the release spring 111 is arranged so as to have a predetermined biasing force between the receiving seat 106b1 that is the other side 106b of the insertion pipe 106 and the plate 108.

[0052] As described above, the plunger 107 is configured in the two-stage diameter of the insertion portion 107a and the other side 107c and the simple shape is achieved. The plunger 107 is not one in which the plunger 7 is configured in the three-stage diameter of the first insertion portion 7b, the second insertion portion 7c having the diameter smaller than the diameter of the first insertion portion 7b, and the other side 7d having the diameter smaller than the diameter of the second insertion portion 7c as described in the above conventional one. In addition, there are not provided the second insertion portion 7c and the second insertion pipe 8 provided on the second insertion portion 7c, which are described in the above conventional one; and therefore, significantly simplified structure can be provided.

[0053] Incidentally, magnetization to the permanent magnet 103 is performed either in the state of the assembly body shown in Fig. 10 or the state of the assembly body shown in Fig. 14; and the plunger 107 is suctioned and retained to the transfer yoke 105 by the suction force of the permanent magnet 103.

[0054] As described above, the configuration of respective components of the release type electromagnetic device is simplified and the number of components is reduced, whereby much trouble and labor are not required for such an assembly work, simple assembly work can be performed, and assembly work can be performed simply and in a short time.

Embodiment 2.

[0055] Embodiment 2 of the present invention will be described with reference to Fig. 15. Fig. 15 is a perspective view showing a yoke in a release type electromagnetic device according to Embodiment 2 of the present invention.

[0056] In the aforementioned Embodiment 1, the description has been made on the case where the yoke closing portion 101d formed at the position of both end surfaces 101c1 of the permanent magnet side yoke bodies 101c of the yoke 101 are provided in the direction orthogonal to the axial direction of the plunger 107, for example, provided linearly. However, this Embodiment 2 is configured such that a yoke closing portion 101e formed at the position of both end surfaces 101c1 of permanent magnet side yoke bodies 101c of a yoke 101 are provided with concavity and convexity which are engaged with each other.

[0057] In this Embodiment 2, the yoke closing portion 101e of the yoke 101 is configured such that a triangle-shaped convex portion and a triangle-shaped concave portion are engaged with each other, and magnetic characteristics can be more improved than the aforementioned Embodiment 1.

Embodiment 3.

[0058] Embodiment 3 of the present invention will be described with reference to Fig. 16. Fig. 16 is a perspective view showing a release type electromagnetic device according to Embodiment 3 of the present invention.

[0059] In the aforementioned Embodiment 2, the description has been made on the case where the yoke closing portion 101e of the yoke 101 is provided with the triangle-shaped convex portion and the triangle-shaped concave portion which are engaged with each other. However, in this Embodiment 3, a yoke closing portion 101f of a yoke 101 is provided with a quadrangle-shaped convex portion and a quadrangle-shaped concave portion which are engaged with each other and the same effect as the aforementioned Embodiment 2 can be exhibited.

Embodiment 4.

[0060] Embodiment 4 of the present invention will be described with reference to Fig. 17. Fig. 17 is a perspective view showing a yoke in a release type electromagnetic device according to Embodiment 4 of the present invention.

[0061] In the aforementioned Embodiment 1, the description has been made on the case where the yoke closing portion 101d formed at the position of both end surfaces 101c1 of the permanent magnet side yoke bodies 101c of the yoke 101 is provided in the direction orthogonal to the axial direction of the plunger 107, for example, provided linearly. However, the yoke 101 formed in such a rectangular shape is easy to be deflected and deformed if external force is applied after forming; and accordingly, the yoke closing portion 101d of the yoke 101 is opened and possibility of influence on magnetic characteristics is generated. The yoke closing portion 101e of the yoke 101 in the aforementioned Embodiment 2 is provided with the triangle-shaped convex portion and the triangle-shaped concave portion which are engaged with each other; and the yoke closing portion 101f of the yoke 101 in the aforementioned Embodiment 3 is provided with the quadrangle-shaped convex portion and the quadrangle-shaped concave portion which are engaged with each other. Even if those yoke closing portions 101e, 101f are opened, concavo-convex engagement is maintained and therefore the influence on the magnetic characteristics can be suppressed.

[0062] However, in this Embodiment 4, the shape of a yoke closing portion 101g of a yoke 101 is brought into concavo-convex engagement in an intricate shape, thereby providing structure in which the yoke closing portion 101g of the yoke 101 is not deformed and opened. More specifically, in the concavo-convex engagement, the size of a convex end portion is larger than the size

of a convex base portion in both end surfaces 101c1 of permanent magnet side yoke bodies 101c of the yoke 101; and the size of a concave end portion is smaller than the size of a concave base portion in both end surfaces 101c1. In the concavo-convex engagement of the yoke closing portion 101g of the yoke 101, the convex end portion is engaged with the concave base portion; and the convex base portion is engaged with the concave end portions. Since both end surfaces 101c1 are configured in this way, the permanent magnet side yoke bodies 101c of the yoke 101 are bent to be brought into concavo-convex engagement of the yoke closing portion 101g of the yoke 101, whereby the yoke closing portion 101g of the yoke 101 can be prevented from being opened and any influence is not exerted on magnetic characteristics.

[0063] As described above, the yoke is configured by bending the single plate into the rectangular shape to form the yoke closing portion at the position of both end surfaces of the permanent magnet side yoke bodies that come into contact with the permanent magnet. However, the yoke closing portions of the yoke are not limited to the aforementioned respective embodiments and the shape of other yoke closing portions can be provided.

[0064] Incidentally, the present invention can freely combine the respective embodiments and appropriately modify and/or omit the respective embodiments, within the scope of the present invention.

[INDUSTRIAL APPLICABILITY]

[0065] The present invention is suitable for achieving a release type electromagnetic device capable of obtaining stable release characteristics.

Claims

1. A release type electromagnetic device comprising:

a bobbin in which a through hole is provided in a central portion, and an electromagnetic coil is mounted on the outer peripheral surface of the central portion between a first bobbin frame body and a second bobbin frame body;
a transfer yoke arranged on the second bobbin frame body side of said bobbin;
a permanent magnet arranged on said transfer yoke;
a yoke in which said bobbin, said electromagnetic coil, said transfer yoke, and said permanent magnet are contained in an inner space;
an insertion pipe inserted in the through hole of said bobbin;
a plunger which is inserted in the inner periphery of said insertion pipe, and moves in a direction of coming into contact with or separating from said transfer yoke; and
a release spring which biases said plunger in the direction of separating from said transfer yoke,

said plunger being retained at a position coming into contact with said transfer yoke by the suction force of said permanent magnet, and being released in the direction of separating from said transfer yoke by the biasing force of said release spring when said electromagnetic coil is energized to reduce the suction force of said permanent magnet,
wherein said yoke is configured by arranging a plunger pass-through side yoke body which is located on the first bobbin frame body side of said bobbin and has a through hole communicated with the through hole of said bobbin, by arranging central side yoke bodies each of which is bent from said plunger pass-through side yoke body to the permanent magnet side, and by arranging permanent magnet side yoke bodies each of which is bent from each of said central side yoke bodies to the center side of the through hole of said bobbin to come into contact with said permanent magnet and to form a yoke closing portion at both end surfaces.

2. The release type electromagnetic device according to claim 1,
wherein said yoke is configured by bending a single plate into a rectangular shape to form the yoke closing portion that comes into contact with said permanent magnet at the position of both end surfaces of said permanent magnet side yoke bodies.

3. The release type electromagnetic device according to claim 1,
wherein said insertion pipe is inserted in the through hole of said plunger pass-through side yoke body and the through hole of said bobbin, one side thereof is extended to the transfer yoke side, and the other side thereof forms a receiving seat which is extended to the radially outer side from the through hole of said plunger pass-through side yoke body on the outside of said plunger pass-through side yoke body.

4. The release type electromagnetic device according to any one of claim 1 to claim 3,
wherein said insertion pipe is inserted in the through hole of said plunger pass-through side yoke body and the through hole of said bobbin from the outer side of said plunger pass-through side yoke body to provide structure that corrects deviations of said yoke and said bobbin.

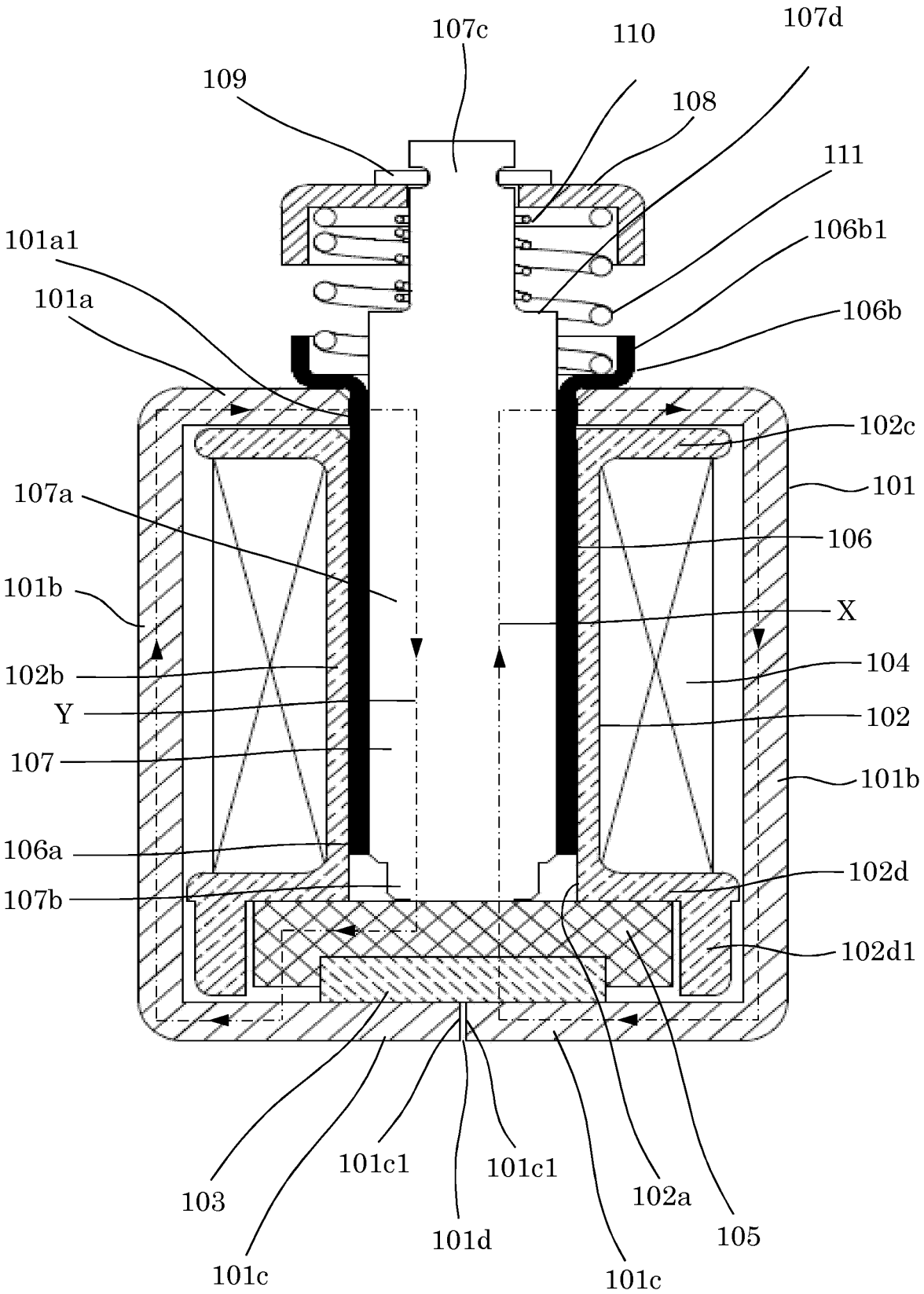
5. The release type electromagnetic device according to claim 3 or claim 4,
wherein said release spring is retained in said receiving seat on the other side of said insertion pipe.

6. The release type electromagnetic device according

to claim 1 or claim 2,
wherein said yoke closing portion located at both end surfaces of said permanent magnet side yoke bodies of said yoke includes concavity and convexity which are engaged with each other.

7. A method of manufacturing a release type electromagnetic device, the method comprising the steps of:

mounting an electromagnetic coil on the outer peripheral surface of a central portion between a first bobbin frame body and a second bobbin frame body of a bobbin provided with a through hole in the central portion;
containing a transfer yoke and a permanent magnet in a surrounding portion provided in said second bobbin frame body of said bobbin;
inserting an assembly body containing said transfer yoke and said permanent magnet in the surrounding portion of said second bobbin frame body of said bobbin into a yoke configured by arranging a plunger pass-through side yoke body which is located on the first bobbin frame body side of said bobbin and has a through hole communicated with the through hole of said bobbin, by arranging central side yoke bodies each of which is bent from said plunger pass-through side yoke body to the permanent magnet side, and by arranging permanent magnet side yoke bodies each of which is bent from each of said central side yoke bodies to the center side of the through hole of said bobbin to come into contact with said permanent magnet and to form a yoke closing portion at both end surfaces;
inserting an insertion pipe from one side of said insertion pipe into the through hole of said plunger pass-through side yoke body of said yoke and the through hole of said bobbin until the other side of said insertion pipe comes into contact with said plunger pass-through side yoke body of said yoke; and
arranging a release spring so as to have a predetermined biasing force between the other side of said insertion pipe and a plate by fitting a plate spring onto the other side of said plunger, inserting an end portion of the other side of said plunger through a through hole of said plate, fitting said release spring onto said plunger after fixing said plate and said plate spring to said plunger by a fixing support body, and inserting said plunger from one side of said plunger through said insertion pipe until a pass-through portion of said plunger is inserted in said insertion pipe.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Y
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101c

FIG. 1

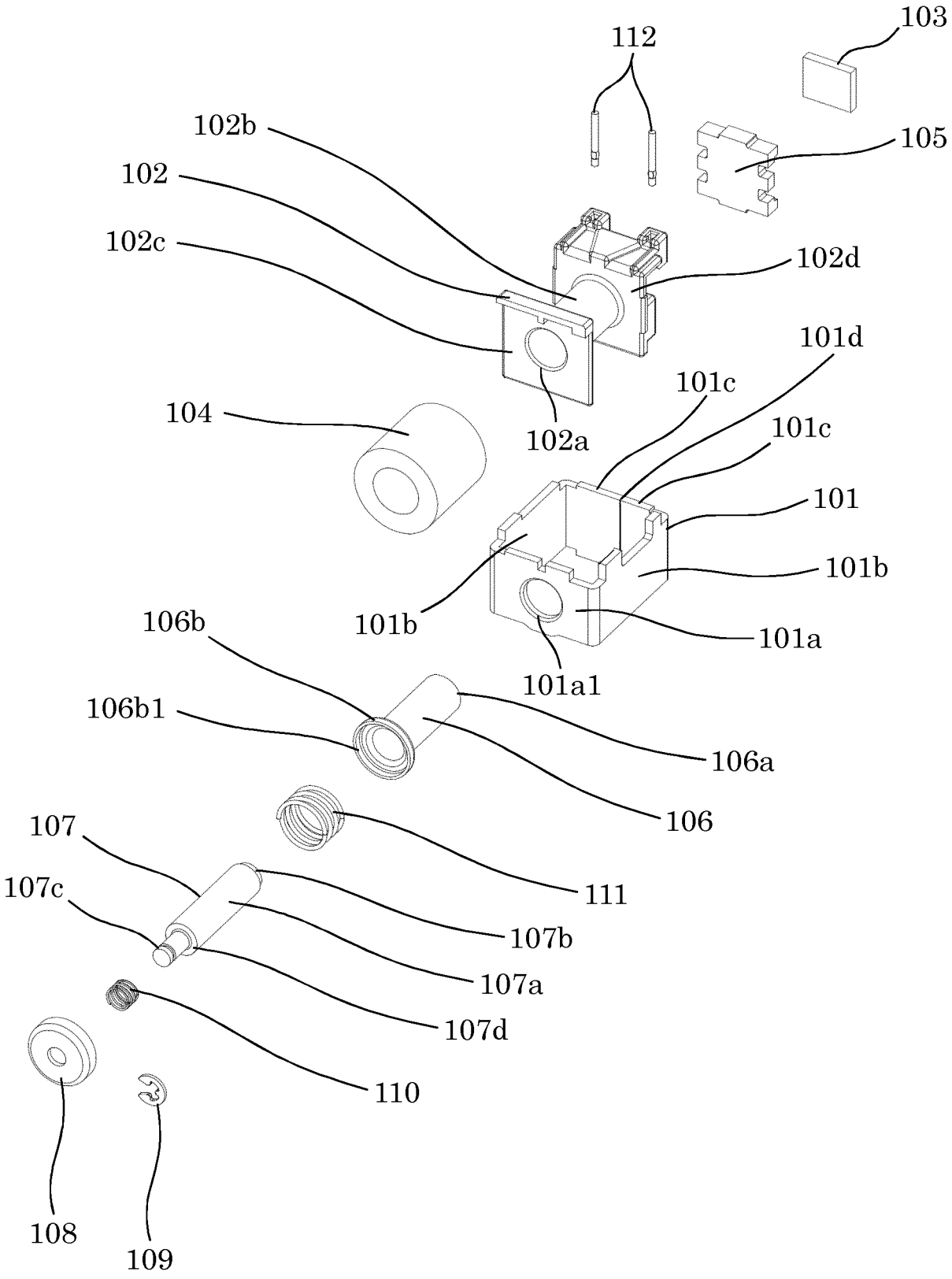
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FIG. 2

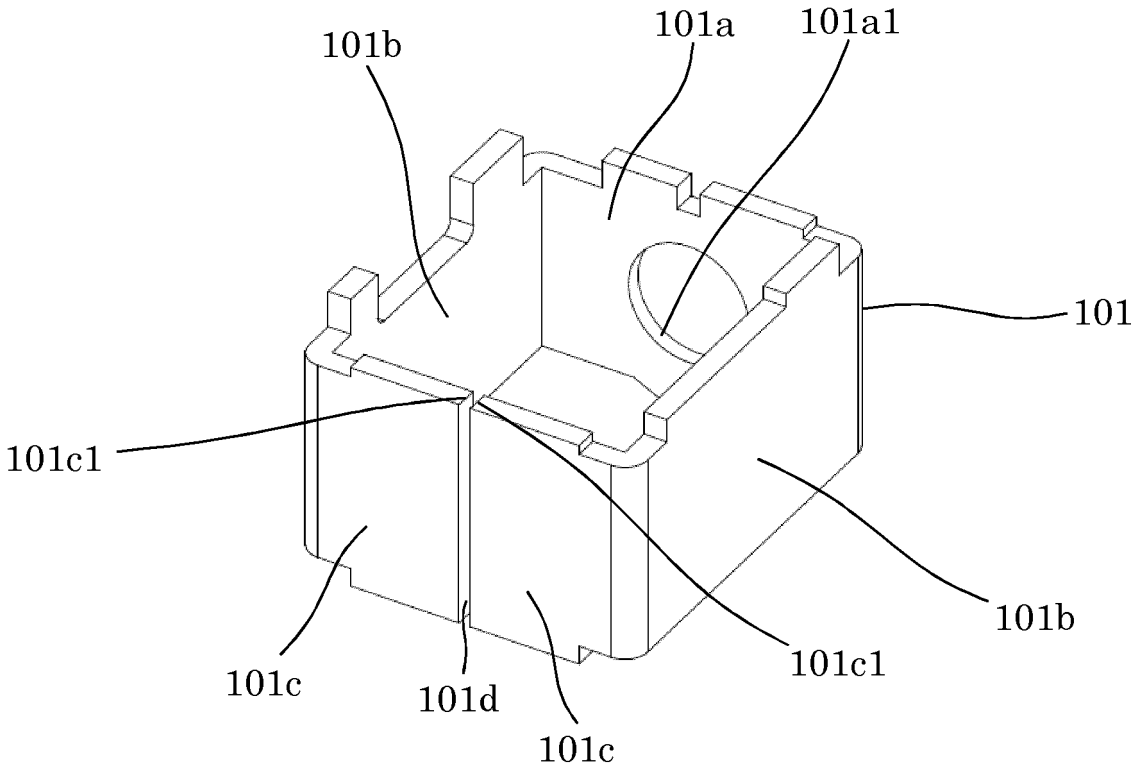


FIG. 3

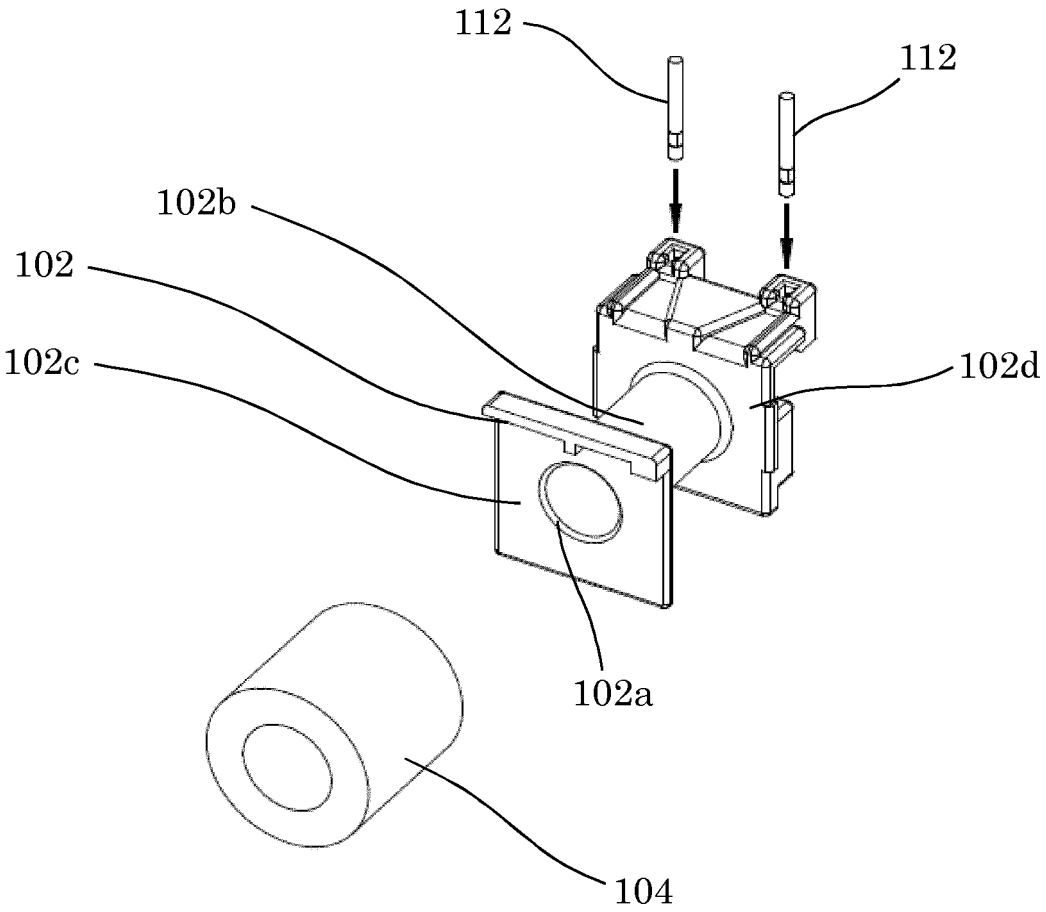


FIG. 4

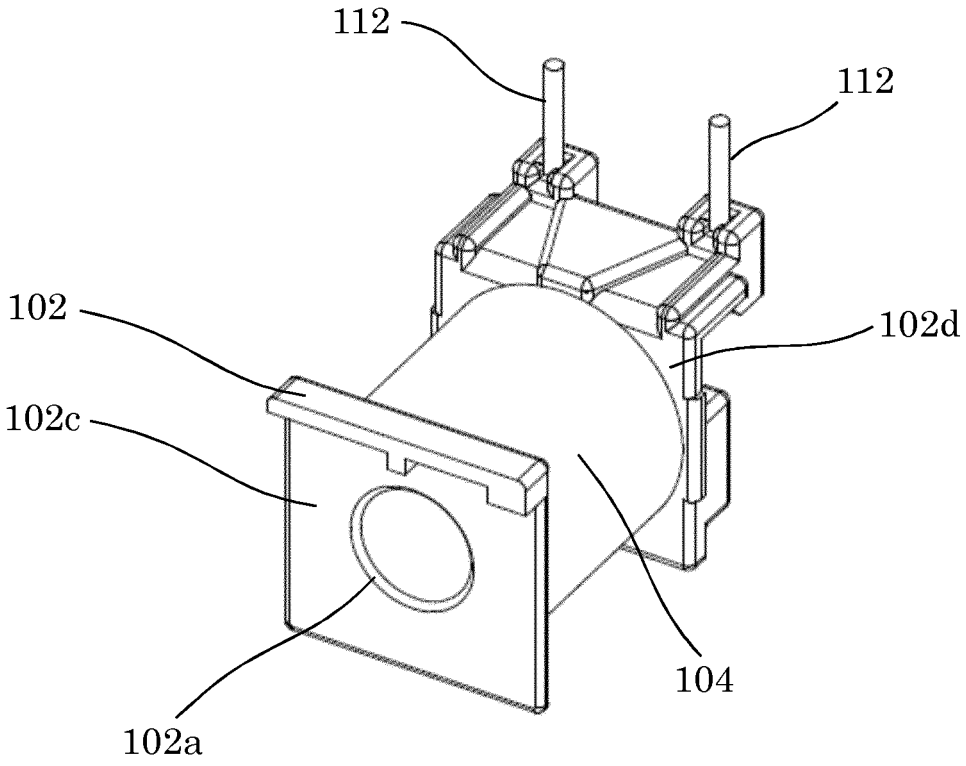


FIG. 5

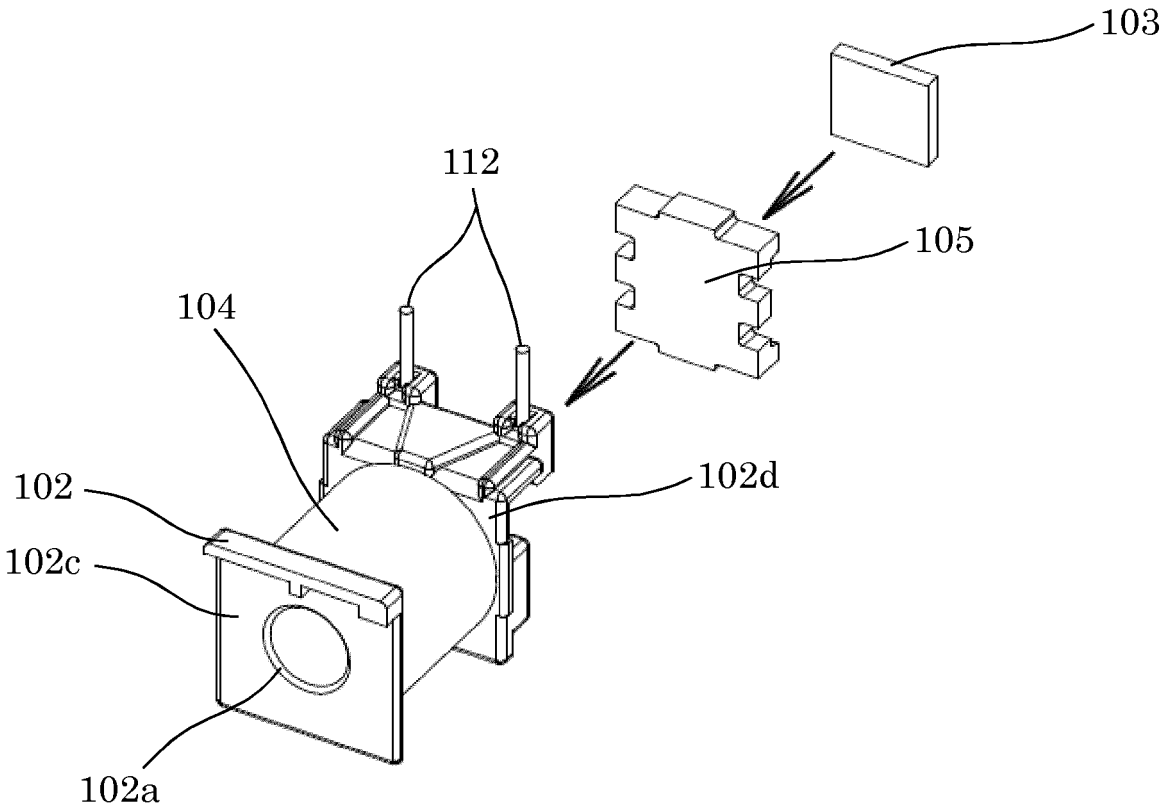
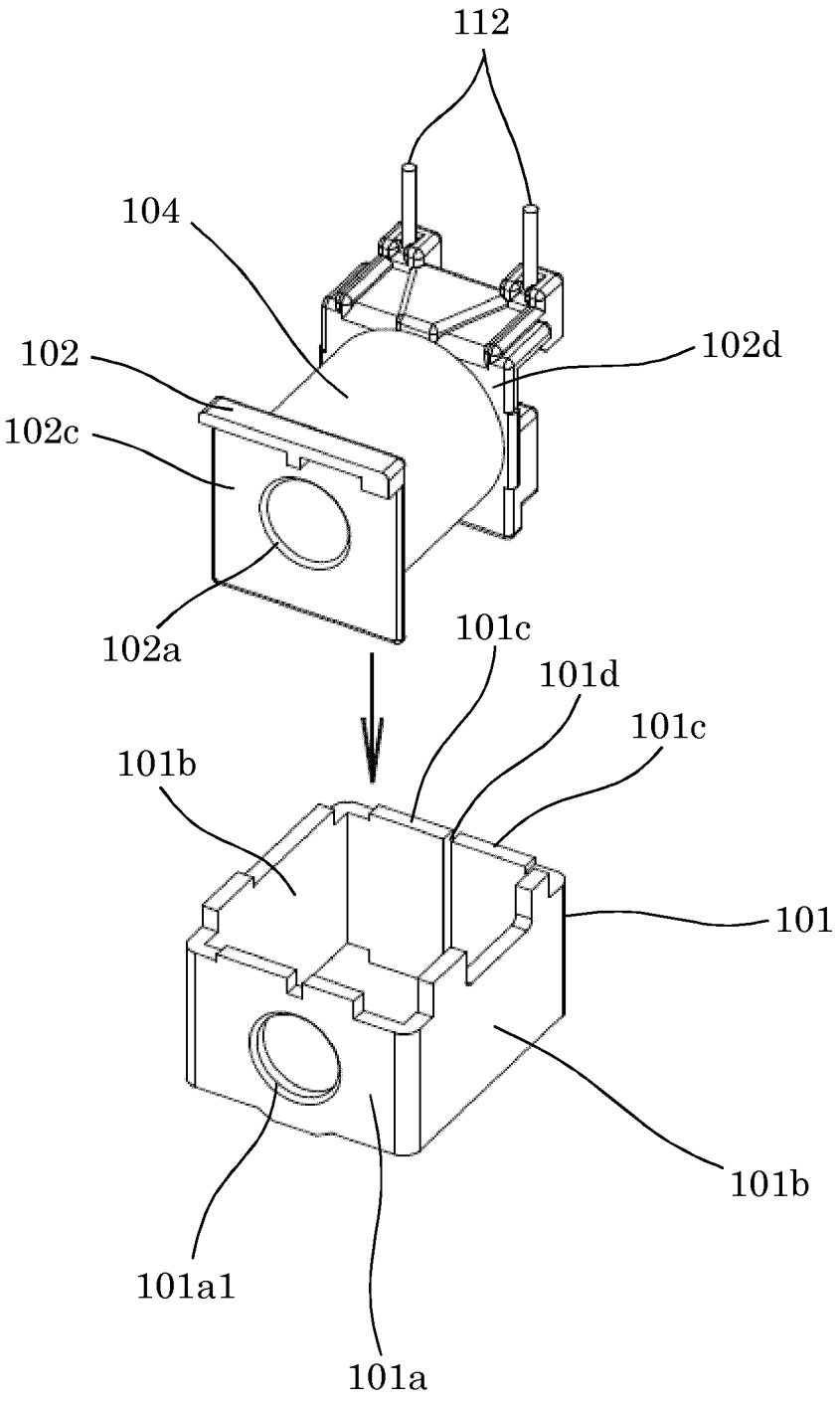


FIG. 6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101a

FIG. 7

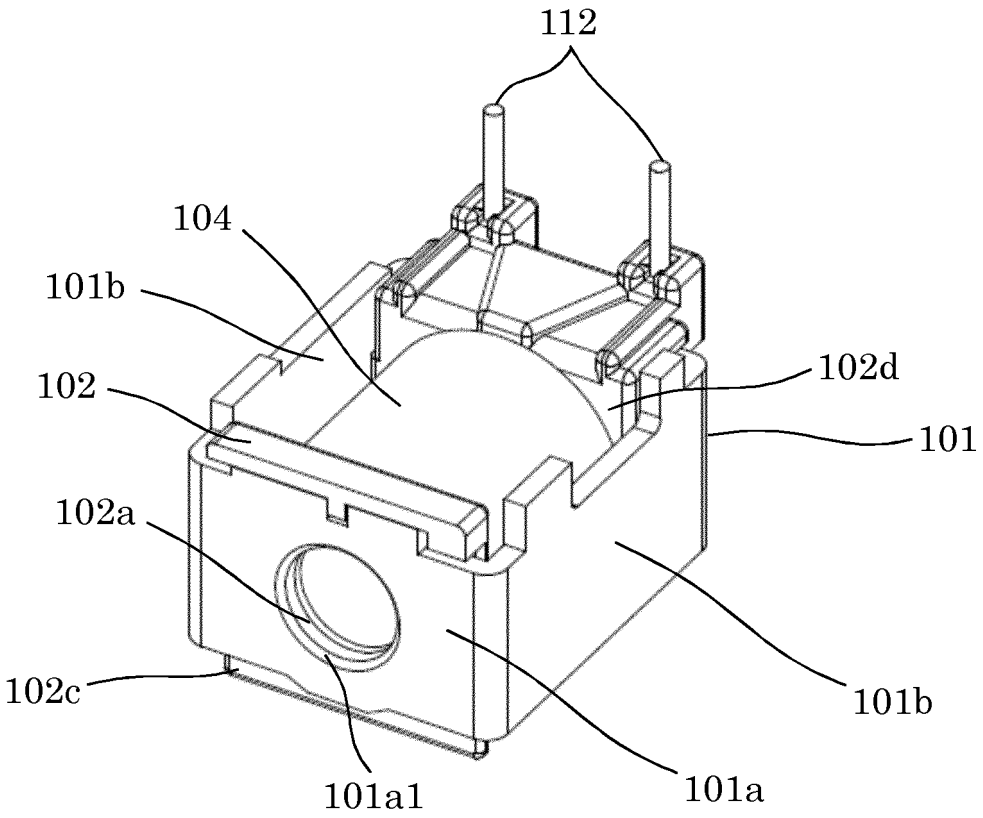
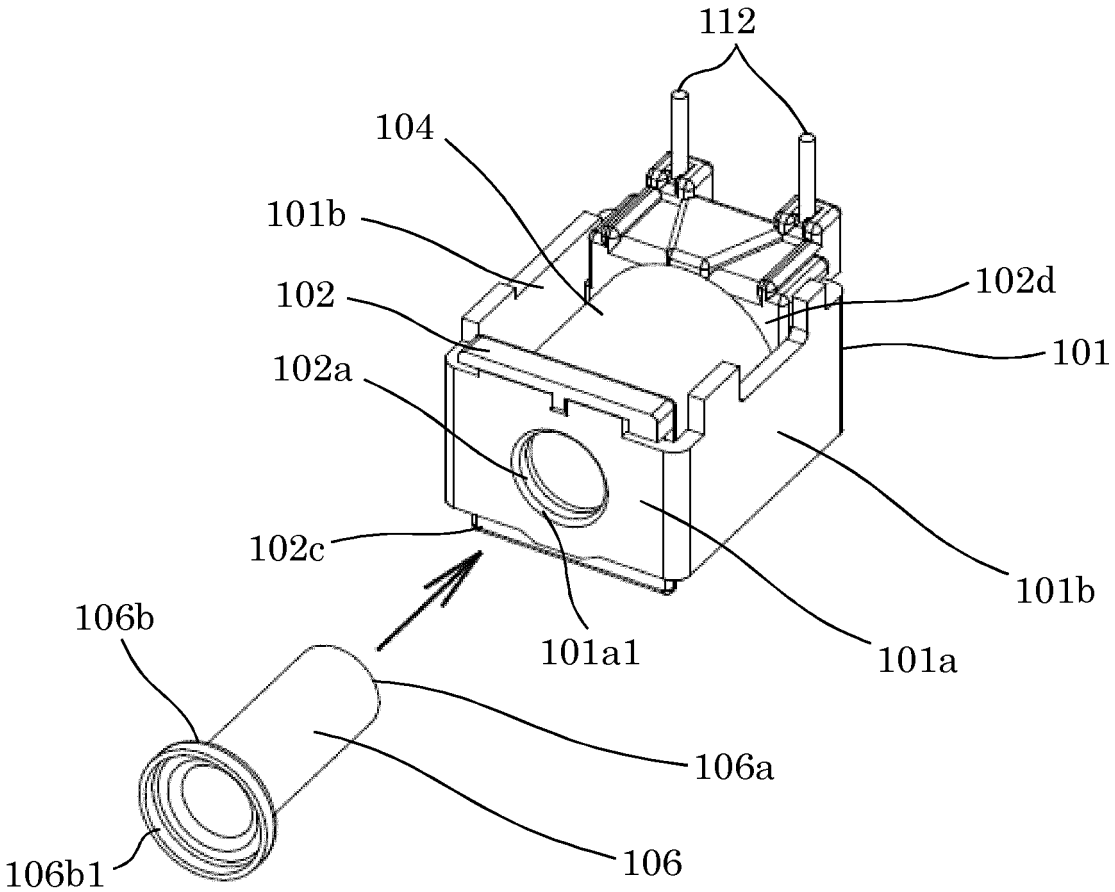


FIG. 8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106
106b1

FIG. 9

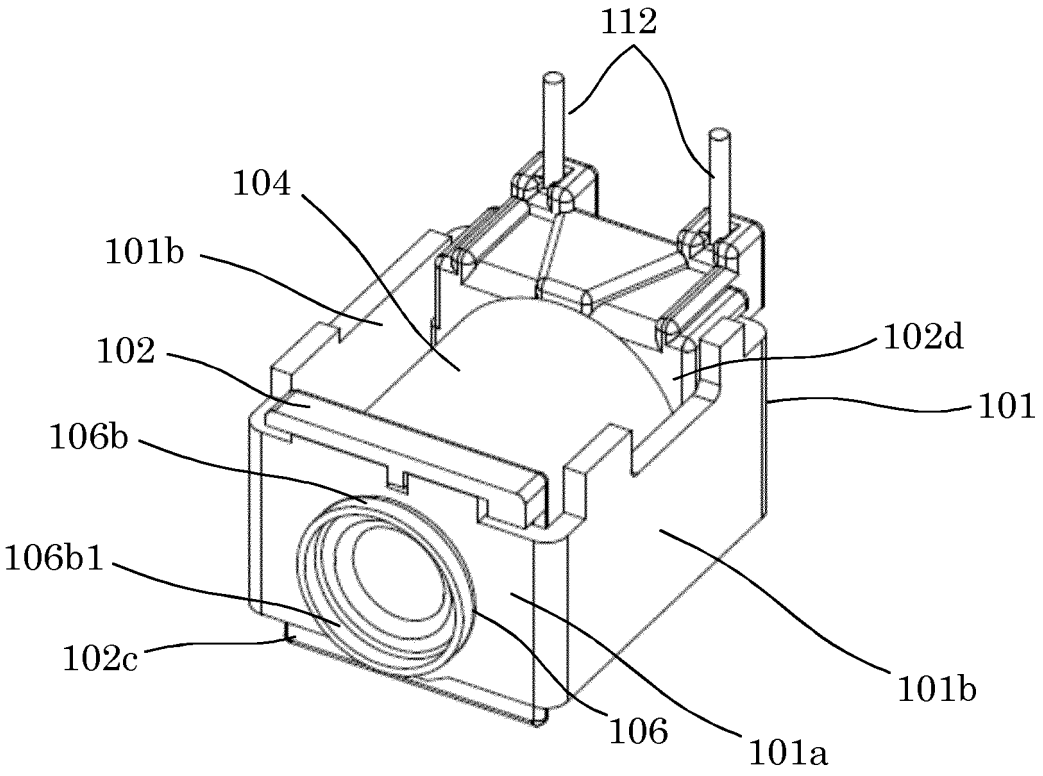
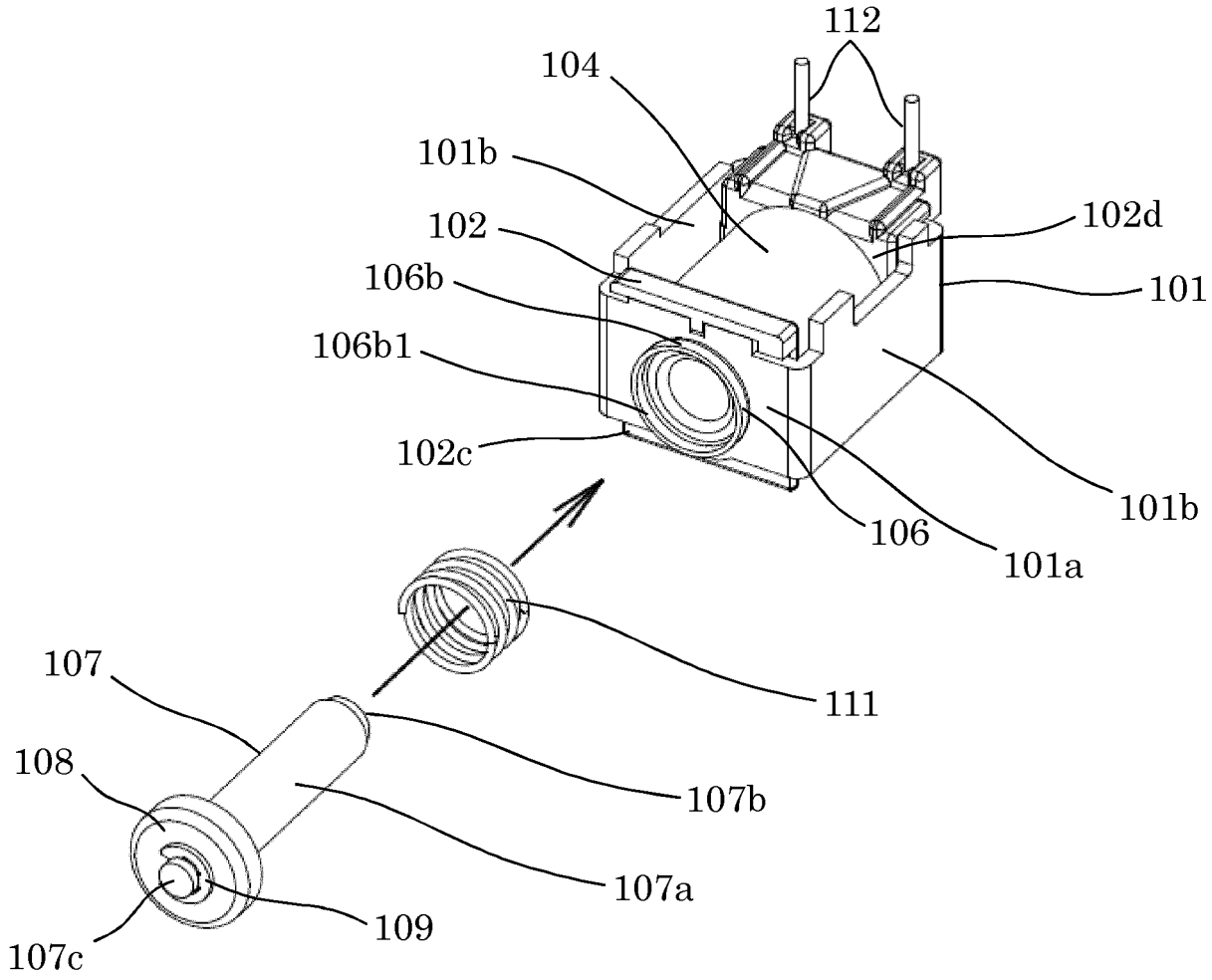


FIG. 10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107b
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109
107c

FIG. 11

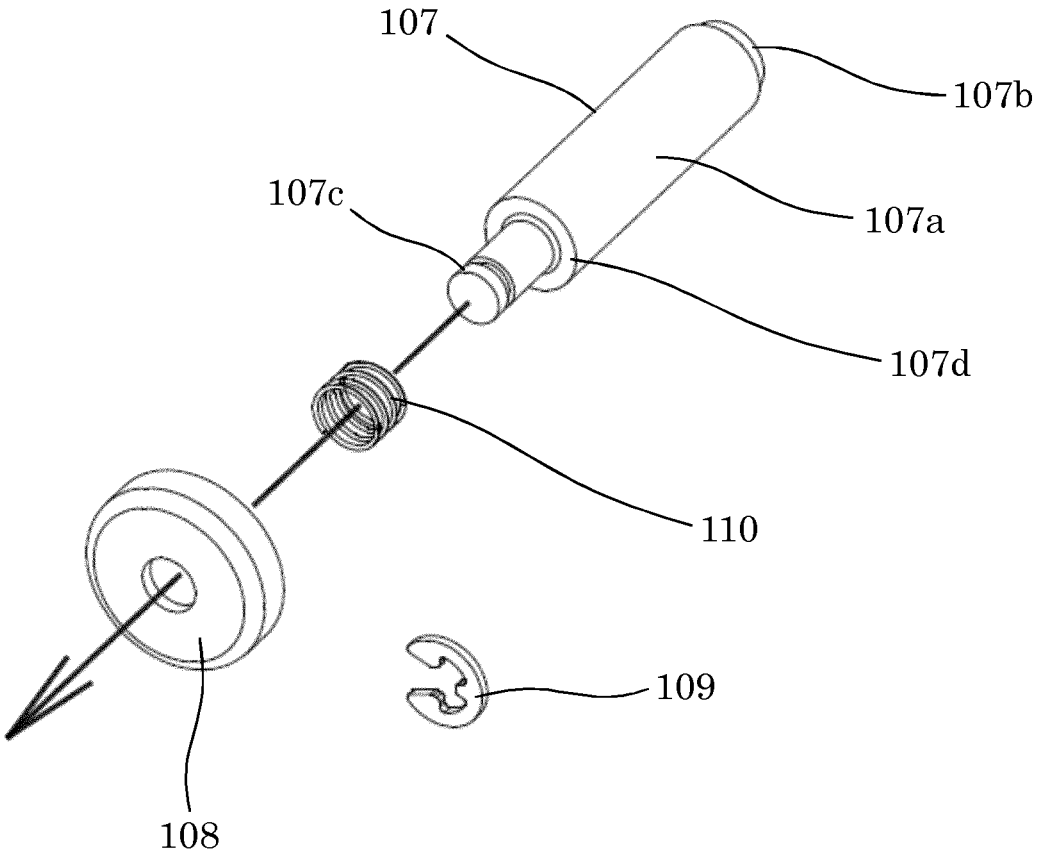


FIG. 12

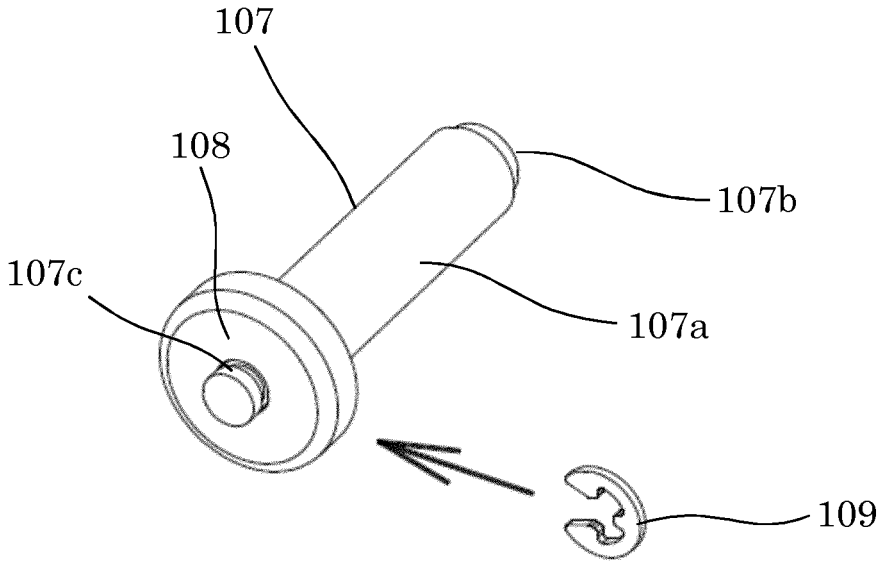
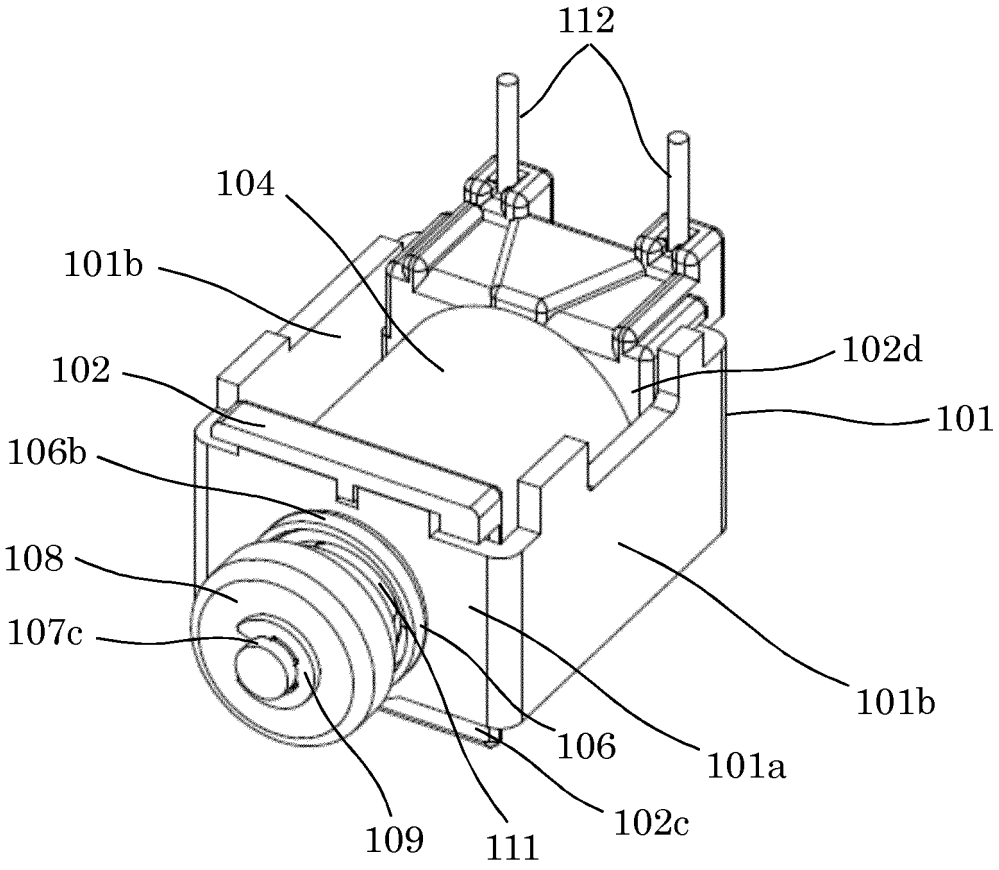


FIG. 13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102c
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101a
101b
101
102d

FIG. 14

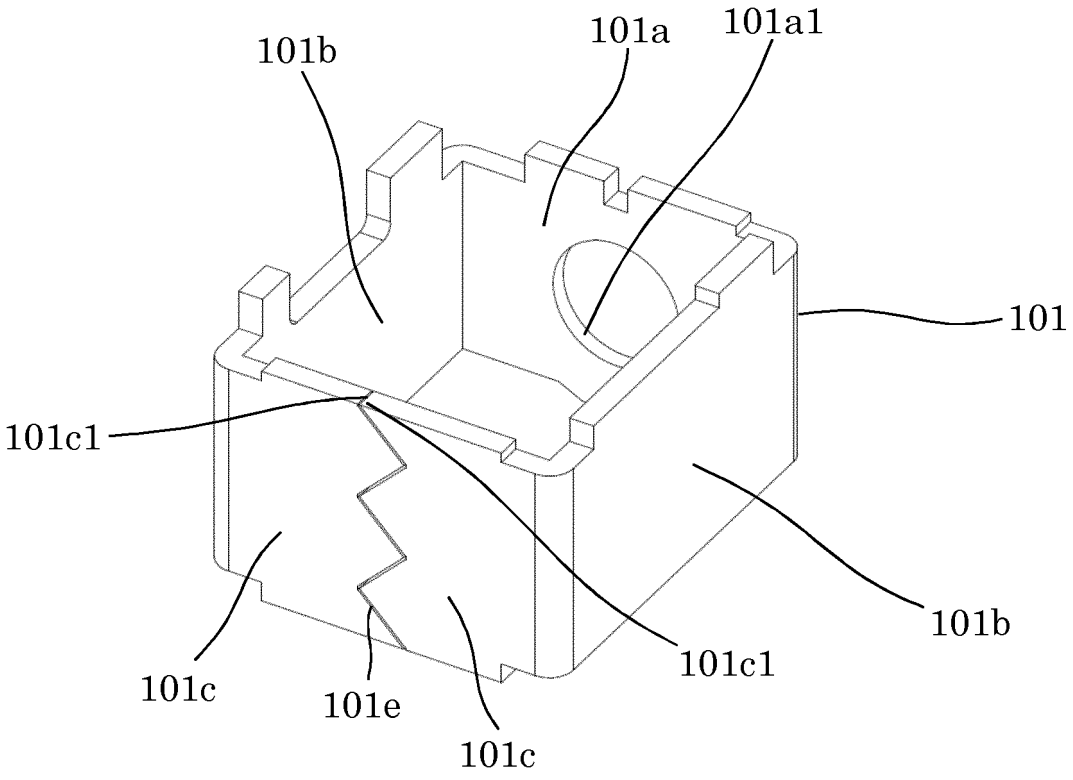


FIG. 15

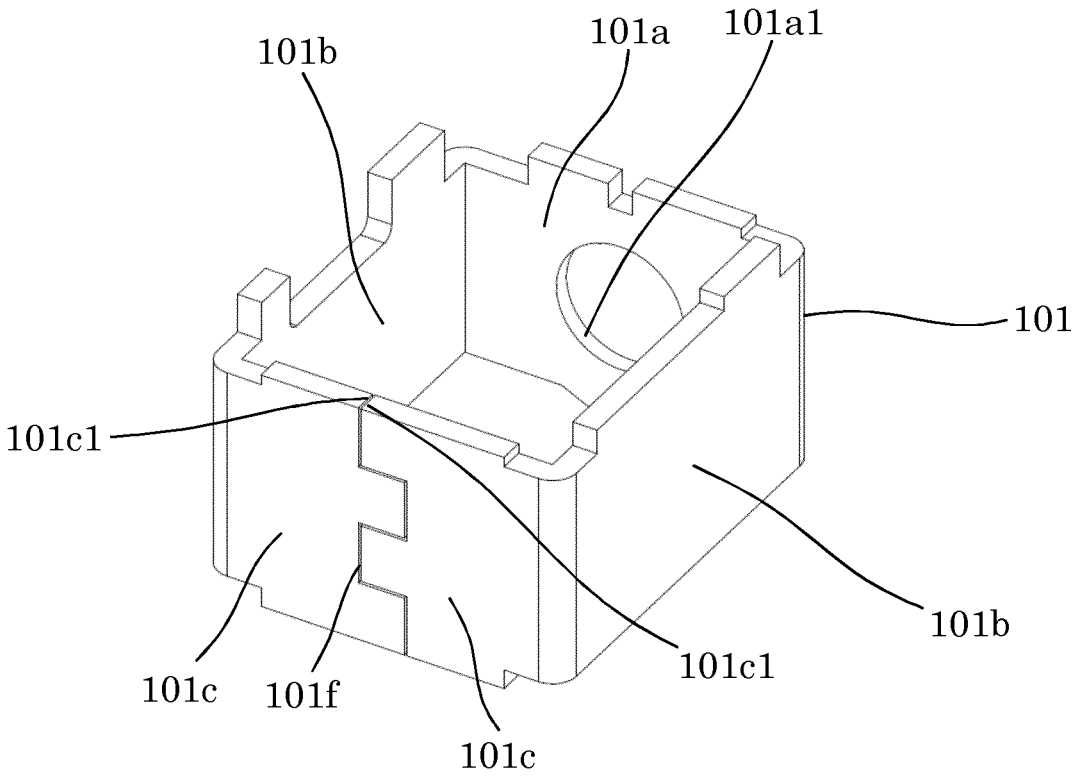


FIG. 16

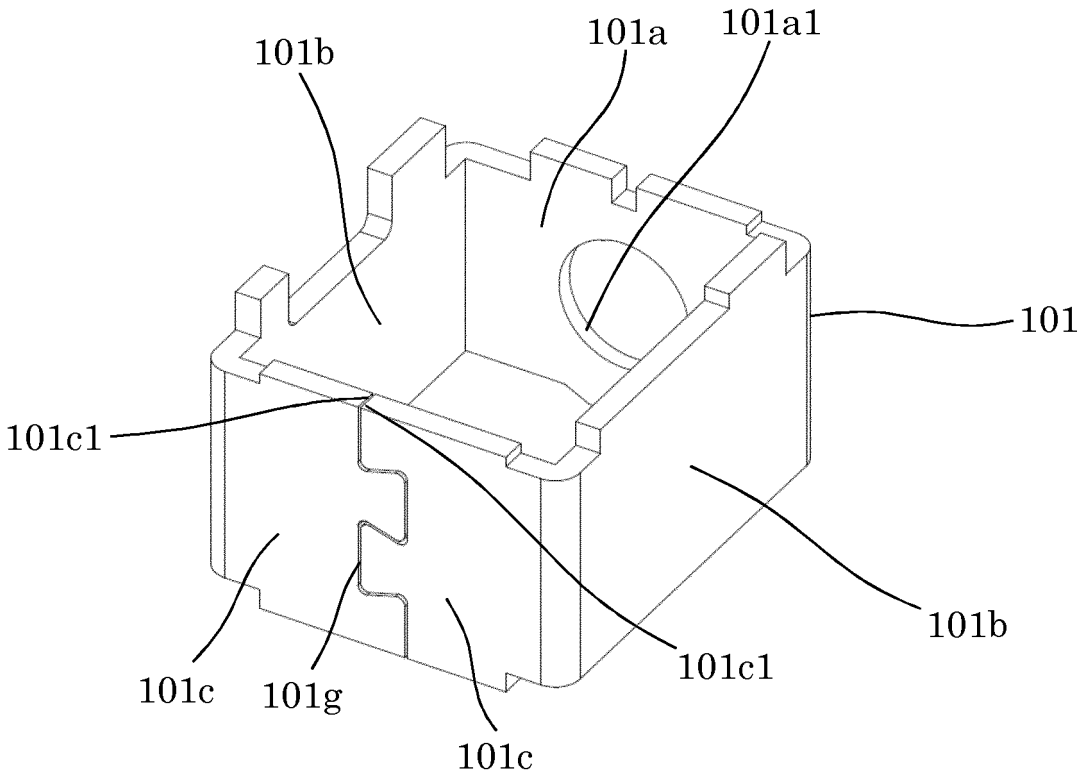
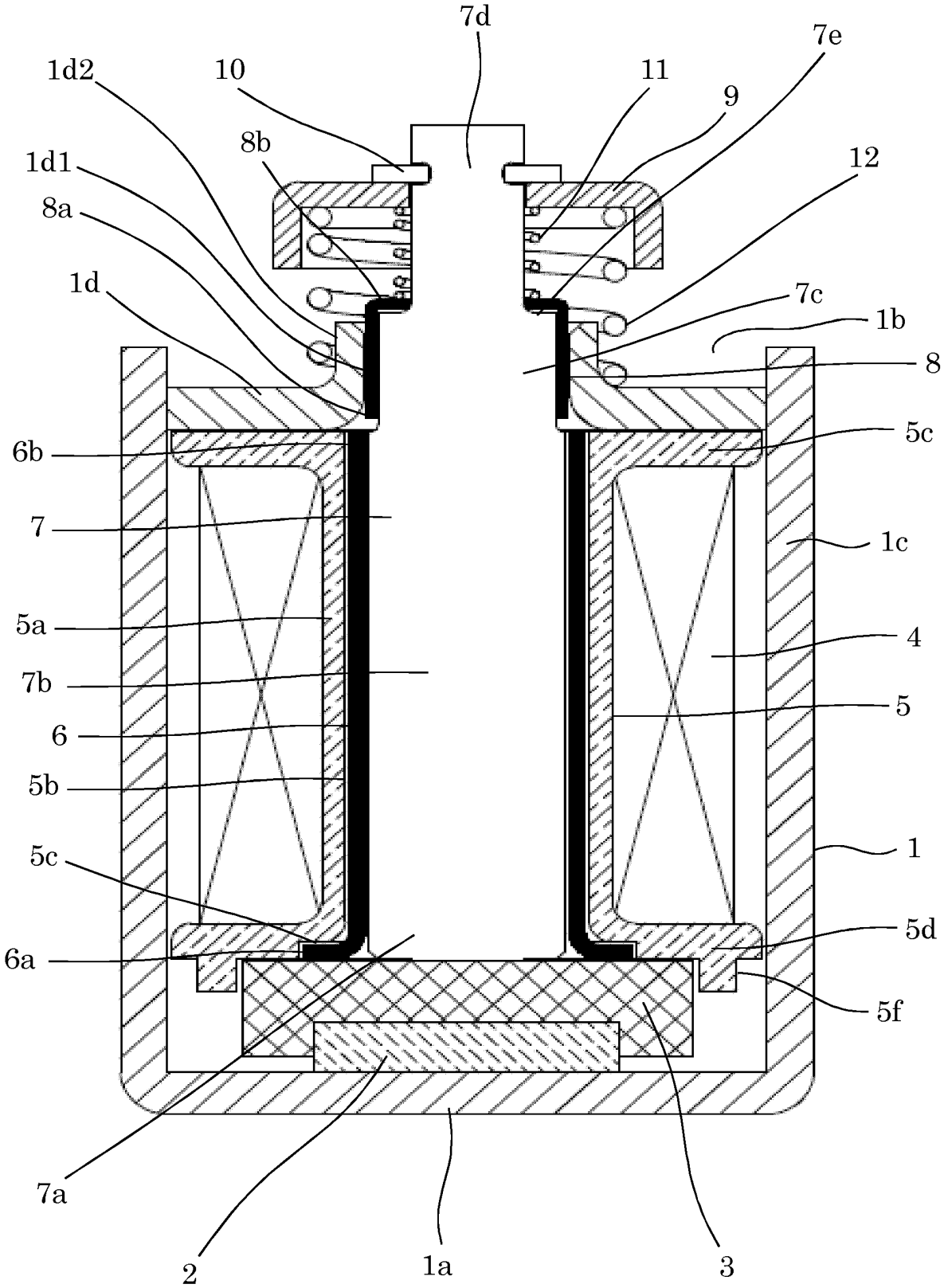


FIG. 17


7d
7e
1d2
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1d
7c
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8
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7
1c
5a
4
7b
5
6
5b
1
5c
5d
6a
5f
7a
2
1a
3

FIG. 18

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/059858

A. CLASSIFICATION OF SUBJECT MATTER
H01F7/04(2006.01)i, *H01F7/121*(2006.01)i, *H01F7/16*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01F7/04, H01F7/121, H01F7/16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014
Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP 2007-258150 A (Fuji Electric FA Components & Systems Co., Ltd.), 04 October 2007 (04.10.2007), paragraphs [0003] to [0012], [0030], [0031]; fig. 1, 15, 16 & KR 10-2007-0089040 A & CN 101030507 A	1-4,6 5,7
Y A	JP 61-228603 A (Harting Elektronik GmbH), 11 October 1986 (11.10.1986), page 3, upper left column, line 8 to upper right column, line 19; lower left column, lines 11 to 15; page 4, upper right column, line 12 to lower left column, line 19; fig. 5 & EP 185262 A1 & DE 3445917 A & DE 3571170 D & DE 3445917 A1 & AT 44188 E & AT 44188 T	1-4,6 5,7

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

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12 June, 2014 (12.06.14)	24 June, 2014 (24.06.14)
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 131680/1987(Laid-open No. 37004/1989) (Alps Electric Co., Ltd.), 06 March 1989 (06.03.1989), specification, page 4, line 7 to page 5, line 10; fig. 1, 2 (Family: none)	6 1-5,7
A	JP 2010-225603 A (Aisin AW Industries Co., Ltd.), 07 October 2010 (07.10.2010), paragraphs [0026] to [0029]; fig. 3, 4 (Family: none)	1-7
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