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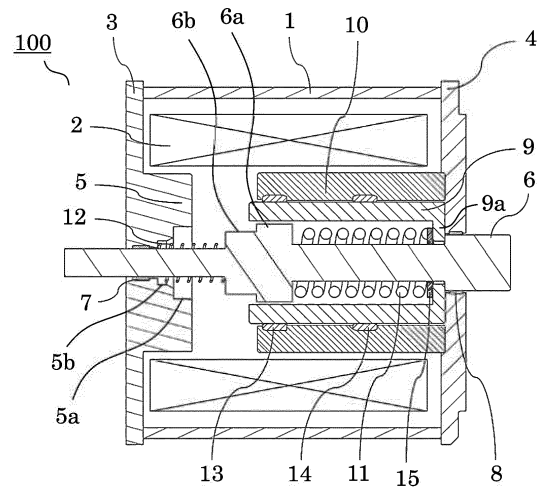
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(54) **ELECTROMAGNETIC ACTUATOR AND ELECTROMAGNETIC ACTUATOR-EQUIPPED CIRCUIT BREAKER**

(57) Provided is an electromagnetic actuator that can relax impact force during opening or closing operation.

Included are: a first yoke (1); a fixed side covering plate (3); a movable side covering plate (4); a fixed core (5); a shaft (6) which passes through the fixed core (5) and the movable side covering plate (4) and has a first protrusion portion (6a); a movable core (9) which is arranged face to face with the fixed core (5) on the outer circumference of the shaft (6) and is provided with a movable core protrusion portion (9a) that protrudes to the circumferential surface of the shaft (6) on one side opposite to the movable side covering plate (4); a second yoke (10) arranged on the outer circumference of the movable core (9); a contact pressure spring (11) arranged between the movable core protrusion portion (9a) of the movable core (9) and the first protrusion portion (6a) of the shaft (6); a movable core bearing (13,14) which is arranged on the second yoke (10) and makes the movable core (9) slide in an axial direction; and an air leak stop prevention plate (15) arranged between the movable core protrusion portion (9a) of the movable core (9) and the contact pressure spring (11).

FIG.3



Description

TECHNICAL FIELD

[0001] The present application relates to an electromagnetic actuator and a circuit breaker equipped with the electromagnetic actuator.

BACKGROUND ART

[0002] In a circuit breaker equipped with an electromagnetic actuator, when a current flows in an electromagnetic coil of the electromagnetic actuator, a magnetic circuit is excited, a movable core in the electromagnetic actuator is driven in a direction toward a fixed core, and a shaft connected to the movable core moves together with the movable core, thereby performing close contact operation of contacts of the circuit breaker. (Refer to Patent Document 1.)

[0003] Furthermore, when the flow of the current to the electromagnetic coil of the electromagnetic actuator is stopped, the magnetic circuit is demagnetized, the movable core in the electromagnetic actuator is driven in the opposite direction of the fixed core, the shaft connected to the movable core moves to the opposite side of the fixed core together with the movable core, thereby performing open contact operation of the contacts of the circuit breaker.

RELATED ART DOCUMENT

PATENT DOCUMENT

[0004] Patent Document 1 JP-A-2003-318020

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

[0005] In the above conventional electromagnetic actuator, there is a possibility that mechanism parts are damaged by impact force during opening or closing operation and relaxation of the impact force during the opening or closing operation is required. Shock absorption rubber material, damper parts, or the like are used for the relaxation of the impact force. Thus, for example, in the electromagnetic actuator of the circuit breaker disclosed in Patent Document 1, the impact force during the opening or closing operation is relaxed by providing the rubber material that relaxes the impact force.

[0006] However, if the rubber material, the damper parts, or the like which relax the impact force are provided, a problem exists in that problems such as securement of an arrangement space and a change or deterioration in material characteristics due to use environment need to be considered.

[0007] The present application has been made to solve the foregoing problem and an object thereof is to provide

an electromagnetic actuator that can relax impact force during opening or closing operation by a simple configuration.

5 MEANS FOR SOLVING THE PROBLEMS

[0008] An electromagnetic actuator disclosed in the present application includes: a first yoke in which an electromagnetic coil is arranged on an inner circumferential side; a fixed side covering plate arranged on one side of the first yoke; a movable side covering plate arranged on the other side of the first yoke; a fixed core arranged on a central portion of the fixed side covering plate; a shaft which passes through the fixed core and the movable side covering plate and has a first protrusion portion; a movable core which is arranged face to face with the fixed core on the outer circumference of the shaft and is provided with a movable core protrusion portion that protrudes to the circumferential surface of the shaft on one side opposite to the movable side covering plate; a second yoke arranged on the outer circumference of the movable core; a contact pressure spring arranged between the movable core protrusion portion of the movable core and the first protrusion portion of the shaft; a movable core bearing which is arranged on the second yoke and makes the movable core slide in an axial direction; and an air leak stop prevention plate arranged between the movable core protrusion portion of the movable core and the contact pressure spring.

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ADVANTAGEOUS EFFECT OF THE INVENTION

[0009] According to the electromagnetic actuator disclosed in the present application, the movable core bearing that makes the movable core slide in the axial direction is arranged on the second yoke and the air leak stop prevention plate is arranged between the movable core protrusion portion of the movable core and the contact pressure spring, whereby there can be obtained an electromagnetic actuator that can relax impact force during opening or closing operation by a simple configuration.

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BRIEF DESCRIPTION OF THE DRAWINGS

45 **[0010]**

FIG. 1 is a front view showing an open contact state of a circuit breaker equipped with an electromagnetic actuator according to Embodiment 1;

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FIG. 2 is a front view showing a close contact state of the circuit breaker equipped with the electromagnetic actuator according to Embodiment 1;

FIG. 3 is a sectional view showing a demagnetization state of the electromagnetic actuator according to Embodiment 1;

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FIG. 4 is a sectional view showing an excitation operation completion state of the electromagnetic actuator according to Embodiment 1; and

FIG. 5 is a sectional view showing a demagnetization state of an electromagnetic actuator according to Embodiment 2.

MODE FOR CARRYING OUT THE INVENTION

Embodiment 1.

[0011] Hereinafter, Embodiment 1 will be described on the basis of FIG. 1 to FIG. 4; and, 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 front view showing an open contact state of a circuit breaker equipped with an electromagnetic actuator according to Embodiment 1. FIG. 2 is a front view showing a close contact state of the circuit breaker equipped with the electromagnetic actuator according to Embodiment 1. FIG. 3 is a sectional view showing a demagnetization state of the electromagnetic actuator according to Embodiment 1. FIG. 4 is a sectional view showing an excitation operation completion state of the electromagnetic actuator according to Embodiment 1.

[0012] A circuit breaker 110 according to Embodiment 1 is a circuit breaker in which, by excitation of an electromagnetic coil of an electromagnetic actuator 100, a close contact state of main contacts is maintained or the main contacts are in an open contact state. As shown in FIG. 1 and FIG. 2, the circuit breaker 110 has a movable side main contact 104 and a fixed side main contact 105 which are a pair of main contacts, the electromagnetic actuator 100 provided with a shaft 6 that operates opening or closing operation of the main contacts, and an arc extinguishing chamber 108.

[0013] A movable conductor 103, a flexible conductor 106, a lower conductor 101, and an open contact spring 107 are provided on the movable side main contact 104 side. An upper conductor 102 is provided on the fixed side main contact 105 side. The arc extinguishing chamber 108 extinguishes an arc discharge produced when the movable side main contact 104 is separated from the fixed side main contact 105 during open contact operation.

[0014] The fixed side main contact 105 that is one of the pair of main contacts is joined to one end portion of the upper conductor 102. The movable side main contact 104 that is the other of the pair of main contacts is joined to one end portion of the movable conductor 103 at a position opposite to the fixed side main contact 105. The other end portion of the movable conductor 103 is connected to the lower conductor 101 by the flexible conductor 106. The movable conductor 103 is biased by the shaft 6 of the electromagnetic actuator 100 so that the movable side main contact 104 is opened from or closed to the fixed side main contact 105.

[0015] The movable side main contact 104 and the fixed side main contact 105 are energized via the lower conductor 101 and the upper conductor 102, respective-

ly. The movable conductor 103 is driven toward the upper conductor 102, and thereby the movable side main contact 104 is brought into contact with the fixed side main contact 105. Furthermore, the movable conductor 103 is driven in a direction separating from the upper conductor 102, and thereby it is dissolved that the movable side main contact 104 comes in contact with the fixed side main contact 105.

[0016] A state where the movable side main contact 104 comes in contact with the fixed side main contact 105 is the close contact state of the main contacts shown in FIG. 2; and a state where the movable side main contact 104 is separated from the fixed side main contact 105 is the open contact state of the main contacts shown in FIG. 1.

[0017] Next, description will be made on the configuration of the electromagnetic actuator 100. FIG. 3 corresponds to the open contact state of the circuit breaker 110 shown in FIG. 1 and shows the position of the movable core 9 in the demagnetization state of the electromagnetic actuator 100. FIG. 4 corresponds to the close contact state of the circuit breaker 110 shown in FIG. 2 and shows the position where the electromagnetic actuator 100 is excited and the movable core 9 comes in contact with the fixed core 5.

[0018] The electromagnetic actuator 100 is configured in the following way. An electromagnetic coil 2 is arranged on the inner circumferential side of a first yoke 1; a fixed side covering plate 3 is arranged on one side of the first yoke 1; a movable side covering plate 4 is arranged on the other side of the first yoke 1; a fixed core 5 is arranged on a central portion of the fixed side covering plate 3; and a shaft 6 passes through the fixed side covering plate 3, the fixed core 5, and the movable side covering plate 4.

[0019] The shaft 6 has: a first protrusion portion 6a; and a second protrusion portion 6b which is provided consecutively to the first protrusion portion 6a and has an outer diameter smaller than the outer diameter of the first protrusion portion 6a. The fixed core 5 is provided with: a first concave portion 5a of the fixed core 5 in which the second protrusion portion 6b of the shaft 6 is incorporated; and a second concave portion 5b of the fixed core 5 which has an inner diameter smaller than the inner diameter of the first concave portion 5a of the fixed core 5.

[0020] The fixed side covering plate 3 side of the shaft 6 is removably supported by a first bearing 7 and the movable side covering plate 4 side of the shaft 6 is removably supported by a second bearing 8. The movable core 9 is arranged face to face with the fixed core 5 on the outer circumference of the shaft 6 and is provided with a movable core protrusion portion 9a that protrudes to the circumferential surface of the shaft 6 on one side opposite to the movable side covering plate 4; a second yoke 10 is arranged on the outer circumference of the movable core 9; a contact pressure spring 11 is arranged between the movable core protrusion portion 9a of the movable core 9 and the first protrusion portion 6a of the shaft 6; and a return spring 12 is arranged between the

second concave portion 5b of the fixed core 5 and the second protrusion portion 6b of the shaft 6.

[0021] A movable core bearing 13,14 is arranged on the inner circumferential side of the second yoke 10 and makes the movable core 9 slide so as to be reciprocally movable in an axial direction. An air leak stop prevention plate 15 is arranged between the movable core protrusion portion 9a of the movable core 9 and the contact pressure spring 11 in the inside of the movable core 9 and suppresses air from flowing out to the outside.

[0022] Next, description will be made on the operation of the electromagnetic actuator 100. First, the electromagnetic coil 2 is energized and a current flows, and thereby the magnetic circuit composed of the movable core 9, the fixed core 5, the first yoke 1, the fixed side covering plate 3, the movable side covering plate 4, and the second yoke 10 is excited. Then, the movable core 9 that is removably supported by the movable core bearing 13,14 moves while sliding toward the fixed core 5.

[0023] At this point, the shaft 6 connected via the contact pressure spring 11 also moves in the same direction and the return spring 12 arranged between the second concave portion 5b of the fixed core 5 and the second protrusion portion 6b of the shaft 6 is compressed. The movable conductor 103 connected to the shaft 6 is driven to the upper conductor 102 side. When the movable side main contact 104 comes in contact with the fixed side main contact 105, the shaft 6 stops, the movable core 9 further moves to the upper conductor 102 side to compress the contact pressure spring 11, and contact pressure force is applied to the main contacts. After that, the movable core 9 comes in contact with the fixed core 5 and the movement of the movable core 9 is completed, and thereby close contact operation is also completed.

[0024] Furthermore, the energization to the electromagnetic coil 2 is stopped, and thereby the magnetic circuit is demagnetized to eliminate magnetic suction force and the movable core 9 moves by trip force of the contact pressure spring 11 in a direction opposite to a direction in which the fixed core 5 is arranged. At this point, the contact pressure force between the contacts is released and it becomes the open contact state between the contacts. The shaft 6 and the movable core 9 move together by the trip force of the open contact spring 107 and the return spring 12, the movable conductor 103 is driven in a direction to separate the movable side main contact 104 from the fixed side main contact 105, and the main contacts are separated. This makes the circuit breaker 110 to the open contact state shown in FIG. 1.

[0025] Next, description will be made on the relationship of arrangement of the movable core bearing 13,14 and the air leak stop prevention plate 15 in the electromagnetic actuator 100 according to Embodiment 1.

[0026] As described above, when the electromagnetic coil 2 is energized and a current flows from the demagnetization state of the electromagnetic actuator 100 shown in FIG. 3, the movable core 9 starts to move to the fixed core 5 side; and when the current flowing to the

electromagnetic coil 2 is stopped from the excitation state of the electromagnetic actuator 100 shown in FIG. 4, the movable core 9 starts to move in a direction opposite to the direction in which the fixed core 5 is arranged, more specifically, the movable core 9 moves to the movable side covering plate 4 side.

[0027] At this point, the movable core bearing 13,14 is provided on the outer circumferential side of the movable core 9 and the air leak stop prevention plate 15 is provided in the movable core 9, and thereby the air in a movable core movement space 16 can be suppressed from flowing out to the outside. Therefore, the movable core 9 is operated while compressing the confined air and resistance force during operation can be increased; thus, operation speed can be reduced.

[0028] As described above, the movable side main contact 104 is driven together with the movable core 9 and the shaft 6; thus, the electromagnetic actuator 100 covers an air damper effect during opening or closing operation and can relax impact force during the opening or closing operation.

[0029] The movable core 9 is operated while compressing the confined air and the resistance force during the operation can be increased; thus, the operation speed can be reduced. The electromagnetic actuator 100 disclosed in the present application is driven while being connected to the movable side main contact 104 of the circuit breaker 110; thus, the electromagnetic actuator 100 covers the air damper effect during the opening or closing operation and relaxes the impact force.

[0030] As described above, rubber material, damper parts, or the like which relax impact force do not need to be provided; thus, the electromagnetic actuator 100 that can relax the impact force during the opening or closing operation can be obtained by a simple configuration and a reduction in size of the circuit breaker 110 can be achieved.

[0031] Furthermore, the movable core bearing 13,14 that removably supports the movable core 9 is provided on the second yoke 10, and thereby the air from between the second yoke 10 and the movable core 9 can be suppressed from flowing out.

Embodiment 2.

[0032] Embodiment 2 will be described on the basis of FIG. 5; and, in the drawing, identical or equivalent members will be described with the same reference numerals (and letters) assigned thereto. FIG. 5 is a sectional view showing a demagnetization state of an electromagnetic actuator according to Embodiment 2.

[0033] Hereinafter, referring to FIG. 5, description will be made on the configuration of an electromagnetic actuator 100 according to Embodiment 2. In FIG. 5, an air leak hole 17 is provided in a movable side covering plate 4 opposite to a movable core protrusion portion 9a of a movable core 9.

[0034] The movable core 9 moves to a fixed core 5

side during close contact operation; and during open contact operation, the movable core 9 moves in a direction opposite to a direction in which the fixed core 5 is arranged, more specifically, the movable core 9 moves to a movable side covering plate 4 side. However, as shown in FIG. 5, the air leak hole 17 is provided in the movable side covering plate 4; thus, the amount of air in which air in a movable core movement space 16 flows out to the outside can be adjusted by adjusting the hole diameter and the number of holes of the air leak hole 17. Consequently, resistance force during operation can be adjusted and therefore speed adjustment during opening or closing operation can be performed.

[0035] The present application describes various exemplified embodiments and examples; however, various features, aspects, and functions described in one or a plurality of embodiments are not limited to specific embodiments, but are applicable to embodiments individually or in various combinations thereof. Therefore, countless modified examples not exemplified are assumed in technical ranges disclosed in the specification of the present application. For example, there include: a case in which at least one constituent element is modified; a case, added; or a case, omitted; and a case in which at least one constituent element is extracted to combine with constituent elements of other embodiments.

INDUSTRIAL APPLICABILITY

[0036] The present application is suitable for achieving an electromagnetic actuator that can relax impact force during opening or closing operation by a simple configuration.

DESCRIPTION OF REFERENCE NUMERALS

[0037] 1 First yoke, 2 Electromagnetic coil, 3 Fixed side covering plate, 4 Movable side covering plate, 5 Fixed core, 5a First concave portion, 5b Second concave portion, 6 Shaft, 6a First protrusion portion, 6b Second protrusion portion, 9 Movable core, 9a Movable core protrusion portion, 10 Second yoke, 11 Contact pressure spring, 12 Return spring, 13 Movable core bearing, 14 Movable core bearing, 15 Air leak stop prevention plate, 16 Movable core movement space, 17 Air leak hole, 100 Electromagnetic actuator, 110 Circuit breaker

Claims

1. An electromagnetic actuator comprising:

a first yoke in which an electromagnetic coil is arranged on an inner circumferential side;
a fixed side covering plate arranged on one side of the first yoke;
a movable side covering plate arranged on the other side of the first yoke;

a fixed core arranged on a central portion of the fixed side covering plate;

a shaft which passes through the fixed core and the movable side covering plate and has a first protrusion portion;

a movable core which is arranged face to face with the fixed core on the outer circumference of the shaft and is provided with a movable core protrusion portion that protrudes to the circumferential surface of the shaft on one side opposite to the movable side covering plate;

a second yoke arranged on the outer circumference of the movable core;

a contact pressure spring arranged between the movable core protrusion portion of the movable core and the first protrusion portion of the shaft;
a movable core bearing which is arranged on the second yoke and makes the movable core slide in an axial direction; and

an air leak stop prevention plate arranged between the movable core protrusion portion of the movable core and the contact pressure spring.

2. The electromagnetic actuator according to claim 1, further comprising an air leak hole provided in the movable side covering plate opposite to the movable core protrusion portion of the movable core.

3. The electromagnetic actuator according to claim 1 or claim 2,

further comprising: a second protrusion portion of the shaft which is provided consecutively to the first protrusion portion of the shaft and has an outer diameter smaller than the first protrusion portion;

a first concave portion of the fixed core in which the second protrusion portion of the shaft is incorporated;

a second concave portion of the fixed core which has an inner diameter smaller than the first concave portion of the fixed core; and

a return spring arranged between the second concave portion of the fixed core and the second protrusion portion of the shaft.

4. A circuit breaker equipped with an electromagnetic actuator as set forth in any one of claim 1 to claim 3.

FIG.1

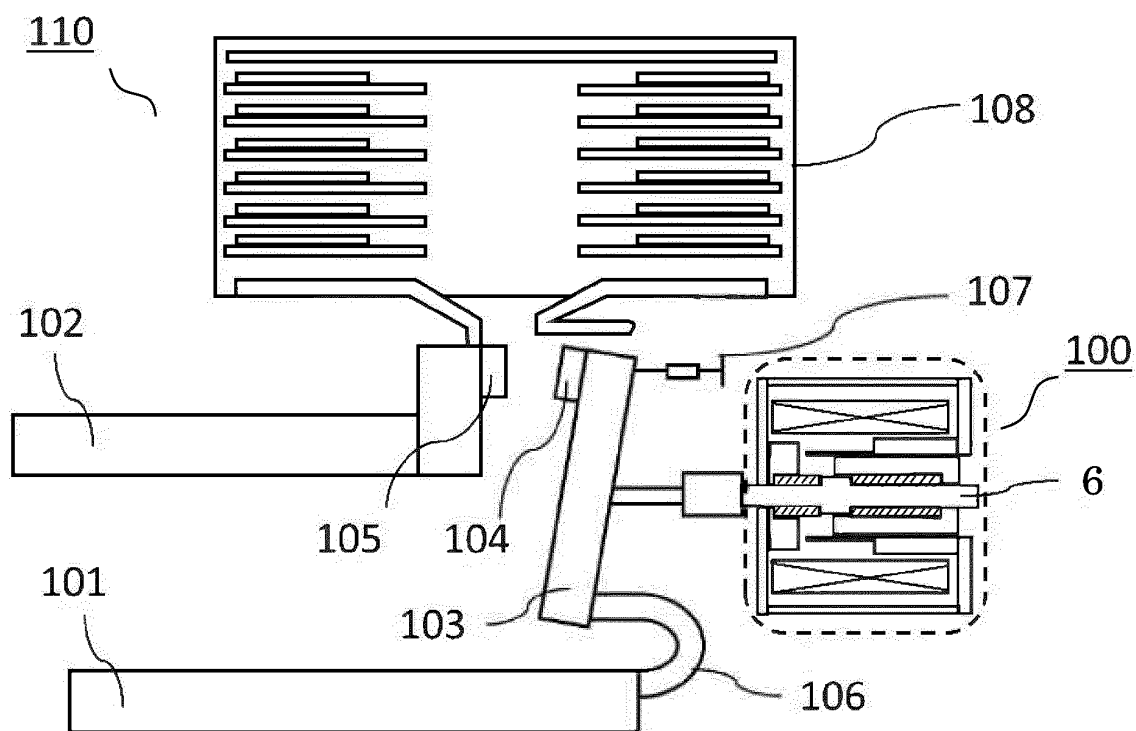


FIG.2

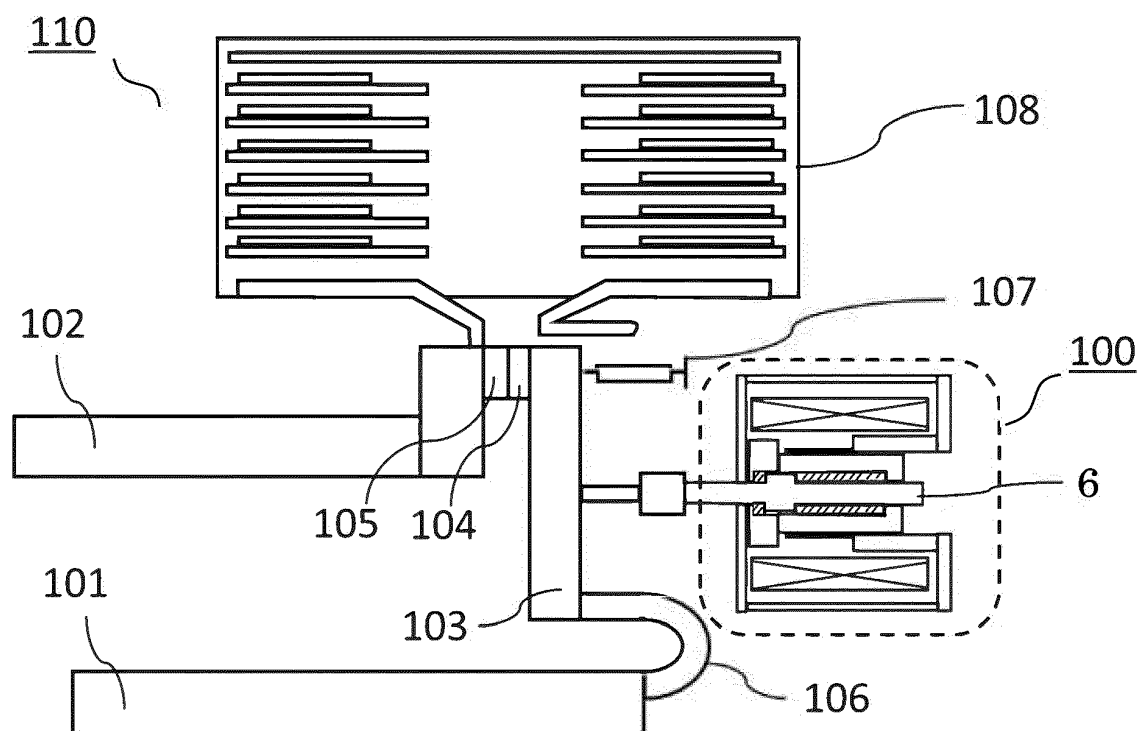


FIG.3

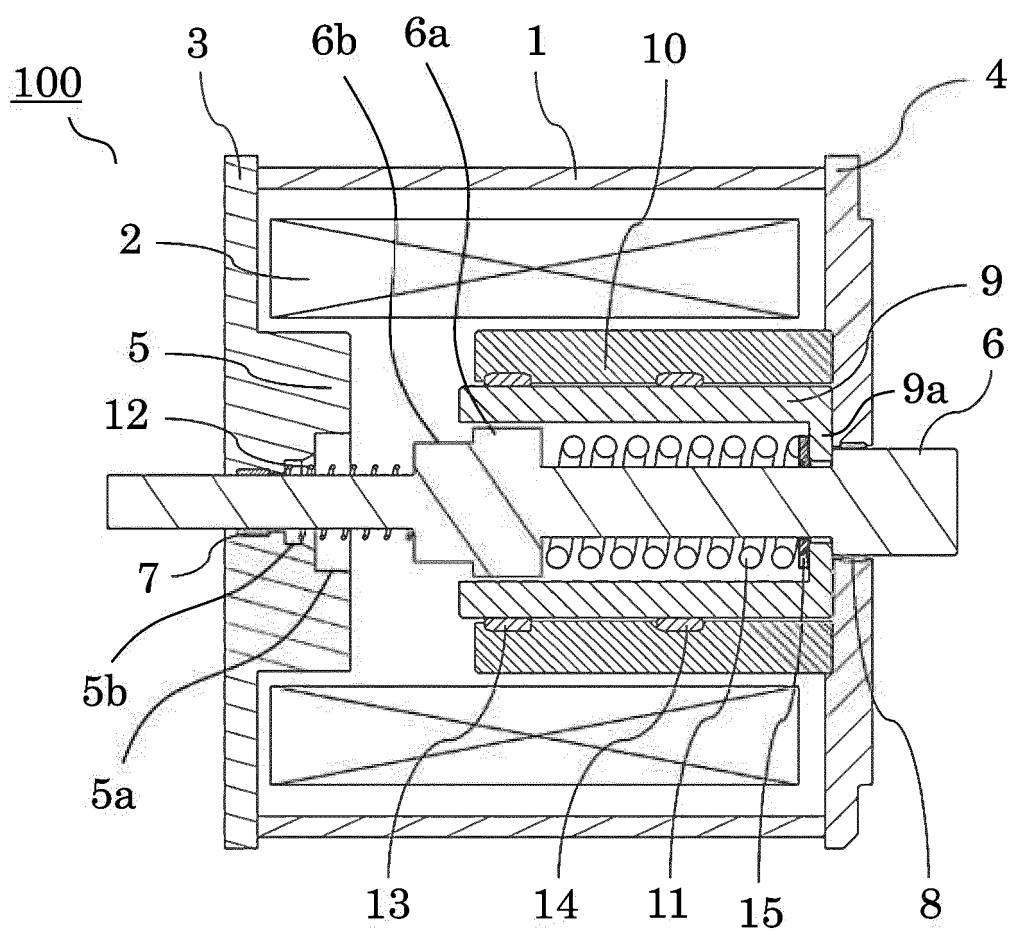


FIG.4

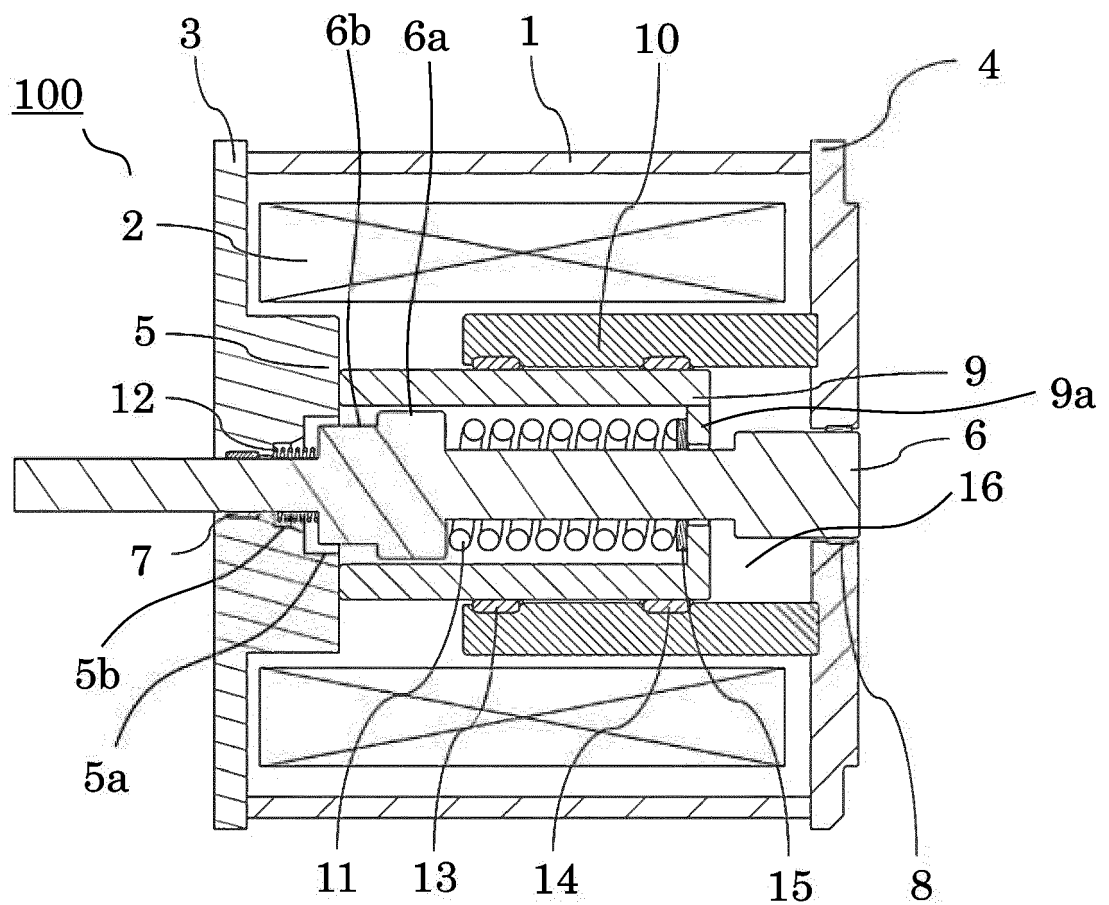
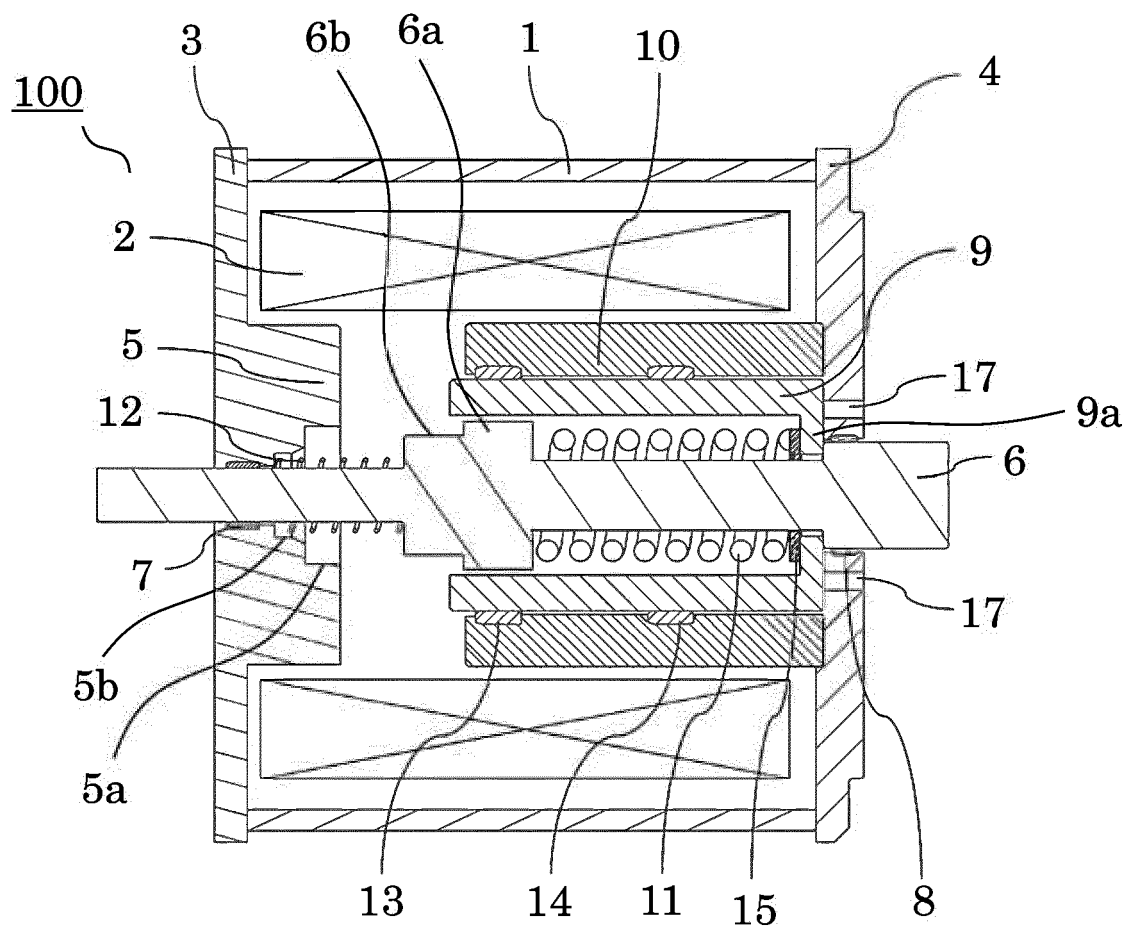


FIG.5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/043730

A. CLASSIFICATION OF SUBJECT MATTER

H01H 33/38(2006.01)i; H01F 7/16(2006.01)i
 FI: H01F7/16 H; H01F7/16 T; H01H33/38

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)
 H01H33/38; H01F7/16

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2021
Registered utility model specifications of Japan	1996-2021
Published registered utility model applications of Japan	1994-2021

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.
A	JP 2003-318020 A (TDS KK) 07 November 2003 (2003-11-07) paragraph [0017], fig. 1, 4	1-4
A	JP 6768174 B1 (MITSUBISHI ELECTRIC CORP.) 14 October 2020 (2020-10-14) fig. 1-4	1-4
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 69429/1988 (Laid-open No. 173911/1989) (MATSUSHITA ELECTRIC WORKS, LTD.) 11 December 1989 (1989-12-11) specification, page 5, line 5 to page 6, line 4, fig. 4, 5	1-4
A	DE 202016103773 U1 (BITRON INDUSTRIE ESPANA, S.A.) 27 July 2016 (2016-07-27) paragraph [0020], fig. 1, 2	1-4



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search
 07 January 2021 (07.01.2021)

Date of mailing of the international search report
 19 January 2021 (19.01.2021)

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Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/JP2020/043730

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 2003-318020 A	07 Nov. 2003	(Family: none)	
JP 6768174 B1	14 Oct. 2020	(Family: none)	
JP 1-173911 U1	11 Dec. 1989	(Family: none)	
DE 202016103773 U1	27 Jul. 2016	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2003318020 A [0004]