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(54) A MAGNETIC CIRCUIT SWITCHING DEVICE WITH SINGLE-SIDED ATTRACTION

(57) A magnetic circuit switching device with single-sided attraction includes a housing (10) with a first side (11) and a second side (12) individually arranged at either side, where the first side (11) has an attraction surface (13) to attract an iron core (30); a permanent magnet (50) having a first type magnetic pole (51) and a second type magnetic pole (52) individually arranged at inner and outer side with opposite properties; a nonconductive axial tube (60) for the iron core (30) to engage, having an opening (61) at the right side (32) extending to the second side (12) of the housing (10); and a spring (70) providing elastic force for the iron core (30) to displace. With a magnetic path alteration function and the elastic force from the spring (70), the structure is able to keep the iron core (30) in a pre-determined position. Therefore the iron core (30) has a wider stretching range for operation, increasing the possibilities of wider application and ensuring in-time adjusting in case of deviation and wear and tear of the device. Also, the present invention requires less power for operation, thus achieving an energy-saving effect.

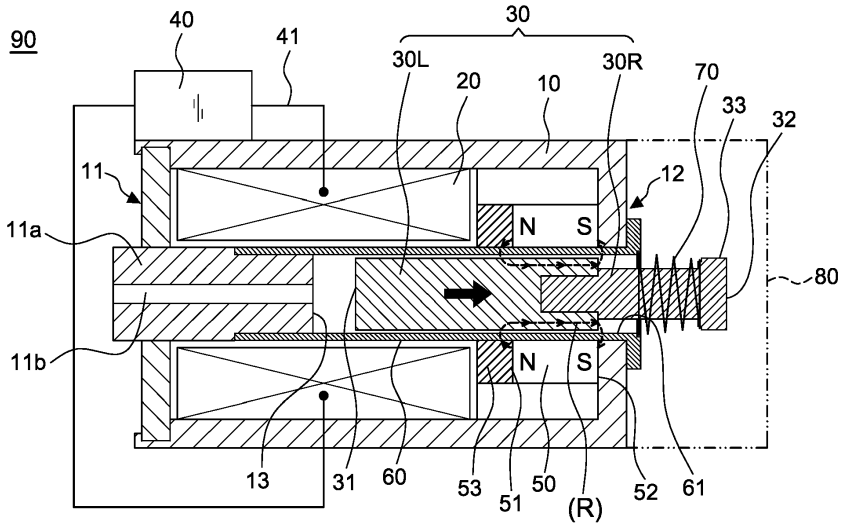

FIG.2A

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention:

[0001] The present invention relates to a magnetic circuit switching device with single-sided attraction, particularly to one that has two magnetic circuits and a single-sided attraction structure for a displaceable iron core to have a wider stretching range in operation.

2. Description of the Related Art:

[0002] The theory of magnetic field effect has been widely applied to valves, solenoids, and relays. A conventional solenoid valve attracts an iron core thereof by a magnetic force produced by an energized coil to open a valve port thereof. However, such solenoid valve has to keep energizing the coil to attract the iron core aside and keep a fixed position of the iron core, so as to keep the valve port opened. Therefore, it needs a great amount of power supply, and the solenoid valve would be overheated and burned by a short circuit after continuous operation.

[0003] The present inventor has therefore disclosed a magnetic power apparatus in US Patent No. 6,246,131 and a magnetic device with double fixing positions for changing the magnetic circuit in US Patent No. 6,057,750. The structure of a magnetic power apparatus 100 is illustrated in FIGS. 1A and 1B, including an outer shell **101,** a coil **102,** an iron core **103,** a permanent magnet **104,** a left attraction surface **105,** and a right attraction surface **106.** When the coil **102** is energized, the iron core **103** displaces leftwards or rightwards due to the magnetic force from the coil **102** or the permanent magnetic **104.** Such structure has both sides to fixedly keep the position of the iron core **103** in operation by the permanent magnet **104,** so it does not need continuous electricity supply, thus being energy-saving and preventing the invention from overheating and burning by a short circuit. The safety and durability are therefore ensured in the improved structure. However, the stretching range **D** of the iron core **103** is restricted due to the double sided fixing position; that is, the right attraction surface **106** is a closed structure **107.** If the stretching range **D** is design to be 5mm, the iron core **103** can only displaces exactly 5mm, shorter or further is impossible. In this case, when an applied device (not shown) has deviation or wear and tear, the operation would be affected. Either the design is the permanent magnet **104** in a column shape with the iron core 103 disposed around the permanent magnet **104** as shown in FIGS. 1A and 1B, or the design is the permanent magnet **104** in a ring shape with the iron core **103** disposed in-between a plurality of permanent magnets **104** as shown in FIG. 5 and 6 in the US Patent No. 6,246,131, the defect would affect the operation.

[0004] Consequently, the inventor has devoted to improving the restriction defect of the stretching range of the iron core **103.**

SUMMARY OF THE INVENTION

[0005] A primary object of the present invention is to provide a magnetic circuit switching device with single-sided attraction that has a magnetic path alteration function and an elastic force from a spring to keep an iron core in a pre-determined position, also enabling the iron core to have a wider stretching range for operation, increasing the possibilities of wider application and ensuring in-time adjusting in case of deviation and wear and tear of the device.

[0006] Another object of the present invention is to provide a magnetic circuit switching device with single-sided attraction that is able to change a normal position of the iron core with less power supply for operation, thus achieving an energy-saving effect.

[0007] In order to achieve the object above, the present invention comprises a housing, a driving circuit, a permanent magnet, a nonconductive axial tube, and a spring according to the annexed claim 1; whereby a magnetic path of the coil starts from the first type magnetic pole to the iron core, the second side, and then the second type magnetic pole when the coil is not energized, forming an outward magnetic circuit to provide a magnetic force for the iron core to displace rightwards with the spring providing an elastic force for the displacement as well, so that the iron core is kept in a position near the right; and when the driving circuit outputting an impulse voltage, the coil is energized, and a magnetic force produced thereby is greater than the magnetic force of the permanent magnet, therefore switching the magnetic path into a path starting from the first type magnetic pole to the iron core, the attraction surface, the first side, the housing, the second side, and then the second type magnetic pole, forming an inward magnetic circuit to force the iron core to displace leftwards and to have the left surface thereof fixedly attracted to the attraction surface for being kept in a position near the left; with the path alteration and the elastic force from the spring, the iron core is able to be stably kept in a position without consuming more electricity energy.

[0008] In addition, according to a particular embodiment, the iron core includes a conductive left section and a nonconductive right section to be engaged to form the iron core, and the driving circuit includes an output wire connected to the coil, which outputs a positive impulse voltage when electrified, and outputs a negative impulse voltage when not electrified, so that the coil is able to alter the magnetic path thereby, therefore displacing the iron core and keeping it in a steady position. Preferably, the first type magnetic pole of the permanent magnet is the north pole and the second magnetic pole is the south pole; advantageously, the first type magnetic pole of the permanent magnet further has a magnetic ring.

[0009] In an applicable embodiment, the attraction sur-

face is arranged at an end of a column body perpendicularly disposed on an inner side of the first side. The column body has an axial through hole arranged therein. And, preferably, the second side further connects to a valve which has a chamber arranged at the right side of the iron core and is separately connected to an inlet hole and an outlet hole so that the right surface of the iron core is able to abut on the inlet hole for closure; and the iron core further has a guiding hole connecting the chamber, so as to guide the air flowing back to the chamber to pass through the iron core and the axial through hole of the column body, to be discharged from the first side.

[0010] With features disclosed above, the present invention has double magnetic circuits with single-sided attraction structure to replace the closed structure design disclosed in US Patent No. 6,246,131, so as to keep an iron core in a pre-determined position. With a magnetic path alteration function and an elastic force from a spring, the iron core has a wider stretching range for operation, increasing the possibilities of wider application and ensuring in-time adjusting in case of deviation and wear and tear of the device. Also, the present invention requires less power for operation, thus achieving an energy-saving effect.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1A is a schematic diagram of a conventional double fixed solenoid valve structure, illustrating an iron core thereof displacing rightwards;

FIG. 1B is a schematic diagram of a conventional double fixed solenoid valve structure, illustrating an iron core thereof displacing leftwards;

FIG. 2A is a sectional view of the invention in an applicable embodiment, illustrating an iron core thereof displacing rightwards;

FIG. 2B is a sectional view of the invention in an applicable embodiment, illustrating an iron core thereof displacing leftwards;

FIG. 3A is a schematic diagram of FIG. 2A, showing a magnetic path when the present invention is not activated;

FIG. 3B is a schematic diagram showing a magnetic path when the present invention is activated by a positive impulse voltage;

FIG. 3C is a schematic diagram showing a magnetic path when the iron core is displacing leftwards;

FIG. 3D is a schematic diagram showing a magnetic path after the iron core displaces leftwards;

FIG. 3E is a schematic diagram showing a magnetic path when the present invention is activated by a negative impulse voltage;

FIG. 3F is a schematic diagram showing a magnetic path after the iron core displaces rightwards;

FIG. 4A is an application example of the present invention applied to a solenoid valve, showing rightward displacement of the iron core;

FIG. 4B is an application example of the present invention applied to a solenoid valve, showing leftward displacement of the iron core;

FIG. 5A is another application example of the present invention applied to a solenoid valve, showing rightward displacement of the iron core stopping the air intake;

FIG. 5B is another application example of the present invention applied to a solenoid valve, showing leftward displacement of the iron core enabling the air intake and outlet; and

FIG. 5C is another application example of the present invention applied to a solenoid valve, showing rightward displacement of the iron core stopping the air intake and enabling the air outlet.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0012] Referring to FIGS. 2A and 2B, the present invention includes a housing **10,** a driving circuit **40,** a permanent magnet **50,** a nonconductive axial tube **60,** and a spring **70.**

[0013] The housing **10** has a coil **20** arranged therein for an iron core **30** to linearly displace within. The iron core **20** is at least partially engaged in the coil **20** in normal status. The driving circuit **40** is arranged aside the housing **10** to provide an impulse voltage for path altering of a magnetic force, changing a position of the iron core **30,** and therefore forming a solenoid magnetic device **90;** such structure has been disclosed in the prior art.

[0014] The feature of the present invention lies in that the housing **10** further has a first side **11** and a second side **12** individually arranged at either side thereof, both of which are conductive, and the first side **11** has an attraction surface **13** to attract a left surface **31** of the iron core **30.**

[0015] The permanent magnet **50** has a first type magnetic pole **51** and a second type magnetic pole **52** individually arranged at inner and outer side thereof with opposite properties. The second type magnetic pole **52** contacts the second side **12** of the housing **10** for operation. In this embodiment, the first type magnetic pole **51** of the permanent magnet **50** is the north pole and the second

magnetic pole **52** is the south pole; and a right section **30R** of the iron core **30** is able to pass through an inner periphery of the permanent magnet **50** for operation. The iron core **30** is preferred to include a conductive left section **30L** and a nonconductive right section **30R** to be engaged to form the iron core **30,** but the present invention is not limited to such application. The iron core **30** is also applicable to be formed in one-piece by conductive materials, but the right section **30R** should be arranged with a diameter shorter than the one of the left section **30L** to avoid affecting the magnetic path, so that the magnetic path would follow the direction in the unbroken lines shown in FIG. 3C, entering the south pole and exiting from the north pole, then going along the left section **30L** of the iron core **30.** In short, the magnetic path would not be affected or changed whether the right section **30R** of the iron core **30** is made of conductive materials or not.

[0016] Furthermore, the iron core **30** has a right surface **32** arranged at the corresponding side to the left surface **31.** Referring to FIGS. 5A to 5C, in a preferred embodiment, the left surface **31** and the right surface **32** each has a flat surface arranged thereon for abutment on the attraction surface **13** or a pre-determined position, and the flat surfaces may further have adhesives thereon to ensure a tight and fixed abutment.

[0017] The nonconductive axial tube **60** is arranged for the left section **30L** of the iron core **30** to engage; it has an opening **61** at right side thereof extending to the second side **12** of the housing **10** for the right surface **32** of the iron core **30** to be pushed out from the housing **30.** The spring **70** is arranged around the iron core **30** at a pre-determined position to provide elastic force for the iron core **30.** In this embodiment, the spring **70** is mounted around the right section **30R** of the iron core **30** with its inner end abutting on the opening **61** of the axial tube **60** and its outer end abutting on a protruding flange **33** at the right end of the iron core **30,** so as to provide elastic force for the iron core **30** to displace rightwards. Or the spring **70** can be arranged between the left surface **31** of the iron core **30** and the attraction surface **13** to provide elastic force with the same effect.

[0018] As illustrated in FIG. 2A, whereby a magnetic path of the coil **20** is formed starting from the first type magnetic pole **51 -** the north pole - to the iron core **30,** the second side **12,** and then the second type magnetic pole **52 -** the south pole - when the coil **20** is not energized, thus forming an outward magnetic circuit **R** to provide a magnetic force for the iron core **30** to displace rightwards with the spring **70** providing an elastic force for the displacement as well, so that the iron core **30** is kept in a position near right. A feature of the present invention is that the right surface **32** of the iron core **30** is not restricted by a closed side; it can pass through the second side **12.** Unlike a conventional device, the iron core **30** of the present invention therefore has a wider stretching range for operation. In addition, the second side **12** further connects to a valve **80** which has an inlet hole **81;** the iron core **30** is able to complement any deviation and wear and tear of the device, ensuring in-time adjusting when the right surface **32** is abutting on the inlet hole **81** during operation.

[0019] Further referring to FIG. 2B, when the driving circuit **40** outputs an impulse voltage, the coil **20** is energized and a magnetic force produced thereby is greater than the magnetic force of the permanent magnet **50,** therefore switching the magnetic path into a path starting from the first type magnetic pole **51 -** the north pole - to the iron core **30,** the attraction surface **13,** the first side **11,** the housing **10,** the second side **12,** and then the second type magnetic pole **52 -** the south pole, forming an inward magnetic circuit **L** to force the iron core **30** to displace leftwards and to have the left surface **31** thereof fixedly attracted to the attraction surface **13** for being kept in a position near the left. With the path alteration and the elastic force from the spring **70,** the iron core **30** is able to be stably kept in a position without consuming more electricity energy.

[0020] In this embodiment, the first type magnetic pole **51** of the permanent magnet **50** has a magnetic ring **53** for enhancement of the magnetic force; that is, the magnetic path from the first type magnetic pole **51** would pass the magnetic ring **53** and then go to the iron core **30** for an enhanced magnetic force for operation. If the magnetic force of the permanent magnet **50** is strong enough, the magnetic ring **53** can be optional. Most devices do not have a magnetic ring **53** in view of smaller volume and less cost requirement.

[0021] To further illustrate the magnetic path change in FIGS. 2A and 2B, further referring to FIGS. 3A-3F, when the power supply is off, the coil **20** is not energized, and the magnetic path is the first type magnetic pole **51** → the magnetic ring **53** → the iron core **30** → the second side **12** → the second type magnetic pole **52,** thus forming an outward magnetic circuit **R** as the broken lines shown in FIG. 3A, a schematic diagram of FIG. 2A when the coil **20** is not energized. The iron core **30** therefore receives a rightward pushing force provided by the permanent magnet **50.**

[0022] FIG. 3B illustrates the magnetic path when the device receives a positive impulse voltage. When receiving a positive impulse voltage, the original path of the magnetic force of the permanent magnet **50** (shown in broken lines) would be offset by a magnetic force produced by the power energy (shown in unbroken lines), turning the magnetic path of the permanent magnet **50** into the direction of the path of the coil **20** and forcing the iron core **30** displacing leftwards as shown in FIG. 3C; the magnetic path of the coil **20** is the shortest route. After the iron core **30** displaces leftwards, the magnetic path would become the one shown in FIG. 3C, entering into the second type magnetic pole **52** and exiting from the first type magnetic pole **51.** Then the iron core **30** displaces leftwards to a position shown in FIG. 3D, with the magnetic path being the first type magnetic pole **51** → the magnetic ring **53** → the iron core **30** →the attraction surface **13** → the first side **11** → the housing **10** → the

second side **12** → the second type magnetic pole **52,** thus forming an inward magnetic circuit **L** and keeping the iron core **30** in position without energizing the coil **20.**

[0023] FIG. 3E illustrates the magnetic path when the device receives a negative impulse voltage. The iron core **30** is originally kept leftwards, thus the magnetic path of the coil **20** has to be reverse of the one shown in FIG. 3D to displace the iron core **30** rightwards. When receiving a negative impulse voltage, the magnetic path is shown in unbroken lines in FIG. 3E, producing a force to displace the iron core **30** to the right. The magnetic force in the path shown in broken lines would offset the force produced by the permanent magnet **50** and the attraction surface **13** would repel, therefore displacing the iron core **30** rightwards to a position shown in FIG. 3F. The magnetic path is the shortest so continuous power supply for the coil **20** is not necessary. The path would be the first type magnetic pole **51** → the magnetic ring **53** → the iron core **30** → the second side **12** → the second type magnetic pole **52,** thus forming a closed outward magnetic circuit **R** to provide a rightwards magnetic force for the iron core **30;** Together with the elastic force from the spring **70,** the iron core **30** displaces back to the position shown in FIG. 3A without energizing the coil **20.** The spring **70** offers elastic force for the iron core **30** to displace rightwards, therefore it may increase little counter force when the iron core **30** displaces leftwards; but this would not affect the displacement operation at all. With the spring **70** and the double magnetic circuits, the iron core **30** is able to displace without consuming much power energy, thus achieving an energy-saving feature.

[0024] In short, a feature of the present invention is to displace the iron core **30** by a magnetic force produced from the coil **20.** The magnetic path of the permanent magnet **50** is altered since the path of a magnetic force is the shortest route; without another magnetic force in counter direction, the iron core **30** would keep staying in the same position.

[0025] The driving circuit **40** of the present invention can be disposed aside the housing **10** or isolated and connected to the coil **20** with an output wire **41** as shown in FIGS. 2A and 2B. When the output wire **41** is electrified, the driving circuit **40** would output a positive impulse voltage; when the output wire **41** is not electrified, the driving circuit **40** would output a negative impulse voltage, so that the coil **20** is able to alter the magnetic path thereby, therefore displacing the iron core **30** and keeping it in a steady position.

[0026] FIGS. 4A and 4B illustrate an application example of the present invention applied to a solenoid valve **90A.** The second side **12** further connects to a valve **80** which has a chamber **82** arranged at the right side **32** of the iron core **30** and is separately connected to an inlet hole **81** and an outlet hole **83** so that the right surface **32** of the iron core **30** is able to abut on the inlet hole **81** for closure as shown in FIG. 4A. Referring to FIG. 4B, when the iron core **30** displaces leftwards, the inlet hole **81** opens for air to enter the chamber **82** and to be guided into the outlet hole **83,** then a pre-determined device **84** which is shown in FIG. 5C, so as to function as a solenoid valve **90A.**

[0027] Furthermore, FIGS. 5A-5C illustrated another application example of the present invention applied to a solenoid valve **90A.** The iron core **30** further has a guiding hole **33** connecting the chamber **82,** thereby the iron core **30** close the inlet hole **81** with its right surface **32** as shown in FIG. 5A, and FIG. 5B shows when the inlet hole **81** opens for air to enter the chamber **82** and then to be guided to the outlet hole **83;** in FIG. 5C, the predetermined device **84** is an air discharging device to guide the air flowing back to into the chamber **82** via the outlet hole **83** to pass through the iron core **30** and to be discharged from the first side **11** via an axial through hole **11b** of a column body **11a**. The present invention is especially suitable for such structure of a solenoid valve for features of simple structure and no residual magnetism, but it is also applicable to other electric devices as well.

[0028] With aforesaid structures and measures, the present invention has the outward magnetic circuit **R** and the inward magnetic circuit **L** with the design of single-sided attraction for fixing. By changing path of the magnetic force and the elastic force from the spring **70,** the iron core **30** is able to be kept in a position with a wider stretching range for operation, increasing the possibilities of wider application and ensuring in-time adjusting in case of deviation and wear and tear of the device. The defect in US Patent No. 6,246,131 is therefore overcome. On the other hand, the present invention also requires less power for operation, thus achieving an energy-saving effect.

[0029] Although particular embodiments of the invention have been described in detail for purposes of illustration, various modifications and enhancements may be made without departing from the spirit and scope of the invention. Accordingly, the invention is not to be limited except as by the appended claims.

Claims

1. A magnetic circuit switching device with single-sided attraction, comprising:

a housing (10) including a coil (20) arranged therein for an iron core (30) to linearly displace within; said iron core (30) being at least partially engaged in the coil (20) in normal status;

a driving circuit (40) arranged aside the housing (10) to provide an impulse voltage for path altering of a magnetic force, changing a position of the iron core (30), and therefore forming a solenoid magnetic device;

characterized in that the housing (10) further has a first side (11) and a second side (12) individually arranged at either side thereof, both of which are conductive, and the first side (11)

has an attraction surface (13) to attract a left surface (31) of the iron core (30);
a permanent magnet (50) having a first type magnetic pole (51) and a second type magnetic pole (52) individually arranged at inner and outer side thereof with opposite properties, the second type magnetic pole (52) contacting the second side (12) of the housing (10) and a right section (30R) of the iron core (30) being able to pass through an inner periphery of the permanent magnet (50) for operation;
a nonconductive axial tube (60) for a left section (30L) of the iron core (30) to engage, having an opening (61) at right side thereof extending to the second side (12) of the housing (10) for a right surface (32) of the iron core (30) to be pushed out from the housing (10); and
a spring (70) arranged around the iron core (30) at a pre-determined position to provide elastic force for the iron core (30);
whereby a magnetic path of the coil (20) starts from the first type magnetic pole (51) to the iron core (30), the second side (12), and then the second type magnetic pole (52) when the coil (20) is not energized, forming an outward magnetic circuit (R) to provide a magnetic force for the iron core (30) to displace rightwards with the spring (70) providing an elastic force for the displacement as well, so that the iron core (30) is kept in a position near the right; and when the driving circuit (40) outputting an impulse voltage, the coil (20) is energized, and a magnetic force produced thereby is greater than the magnetic force of the permanent magnet (50), therefore switching the magnetic path into a path starting from the first type magnetic pole (51) to the iron core (30), the attraction surface (13), the first side (11), the housing (10), the second side (12), and then the second type magnetic pole (52), forming an inward magnetic circuit (L) to force the iron core (30) to displace leftwards and to have the left surface (31) thereof fixedly attracted to the attraction surface (13) for being kept in a position near the left; with the path alteration and the elastic force from the spring (70), the iron core (30) is able to be stably kept in a position without consuming more electricity energy.

2. The magnetic circuit switching device with single-sided attraction as claimed in claim 1, wherein the iron core (30) includes a conductive left section (30L) and a nonconductive right section (30R) to be engaged to form the iron core (30).

3. The magnetic circuit switching device with single-sided attraction as claimed in claim 1, wherein the driving circuit (40) includes an output wire (41) connected to the coil (20), which outputs a positive impulse voltage when electrified, and outputs a negative impulse voltage when not electrified, so that the coil (20) is able to alter the magnetic path thereby, therefore displacing the iron core (30) and keeping it in a steady position.

4. The magnetic circuit switching device with single-sided attraction as claimed in claim 1, wherein the first type magnetic pole (51) of the permanent magnet (50) is the north pole and the second magnetic pole (52) is the south pole.

5. The magnetic circuit switching device with single-sided attraction as claimed in claim 4, wherein the first type magnetic pole (51) of the permanent magnet (50) has a magnetic ring (53).

6. The magnetic circuit switching device with single-sided attraction as claimed in claim 1, wherein the attraction surface (13) is arranged at an end of a column body (11a) perpendicularly disposed on an inner side of the first side (11).

7. The magnetic circuit switching device with single-sided attraction as claimed in claim 6, wherein the column body (11a) has an axial through hole (11b) arranged therein.

8. The magnetic circuit switching device with single-sided attraction as claimed in claim 7, wherein the second side (12) further connects to a valve (80) which has a chamber (82) arranged at the right side of the iron core (30) and is separately connected to an inlet hole (81) and an outlet hole (83) so that the right surface (32) of the iron core (30) is able to abut on the inlet hole (81) for closure; and the iron core (30) further has a guiding hole (34) connecting the chamber (82), so as to guide the air flowing back to the chamber (82) to pass through the iron core (30) and the axial through hole (11b) of the column body (11a), to be discharged from the first side (11).

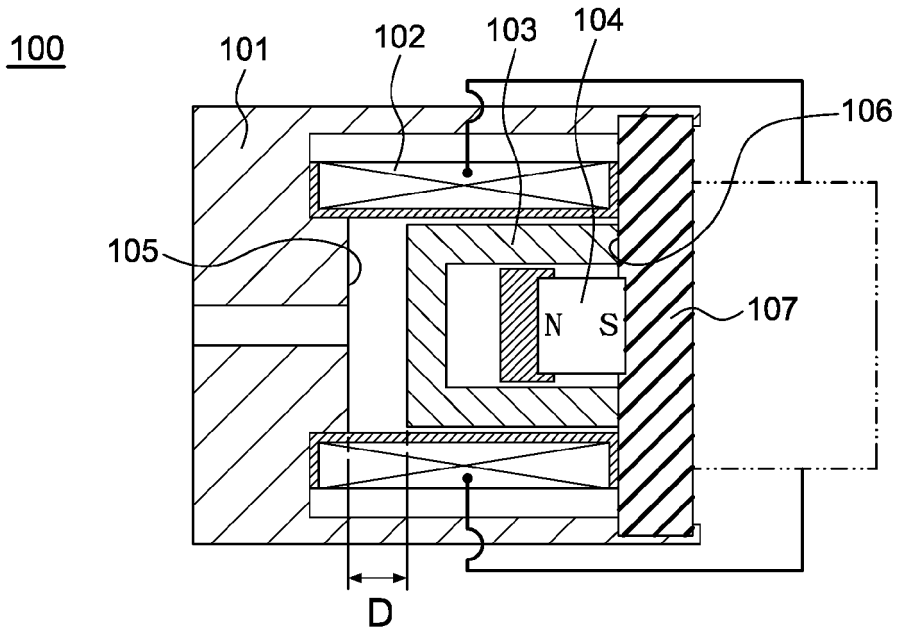


FIG.1A
PRIOR ART

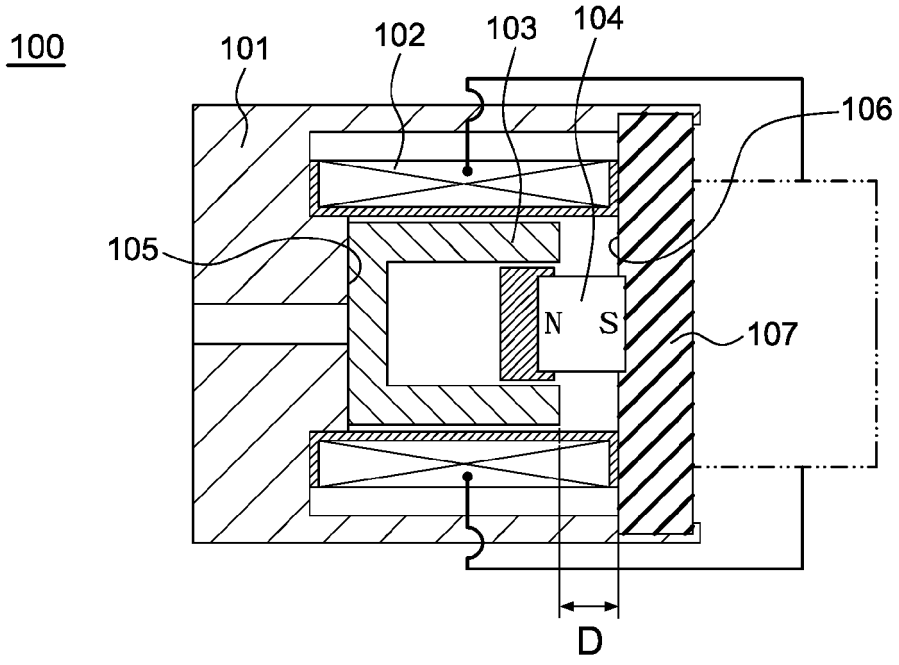
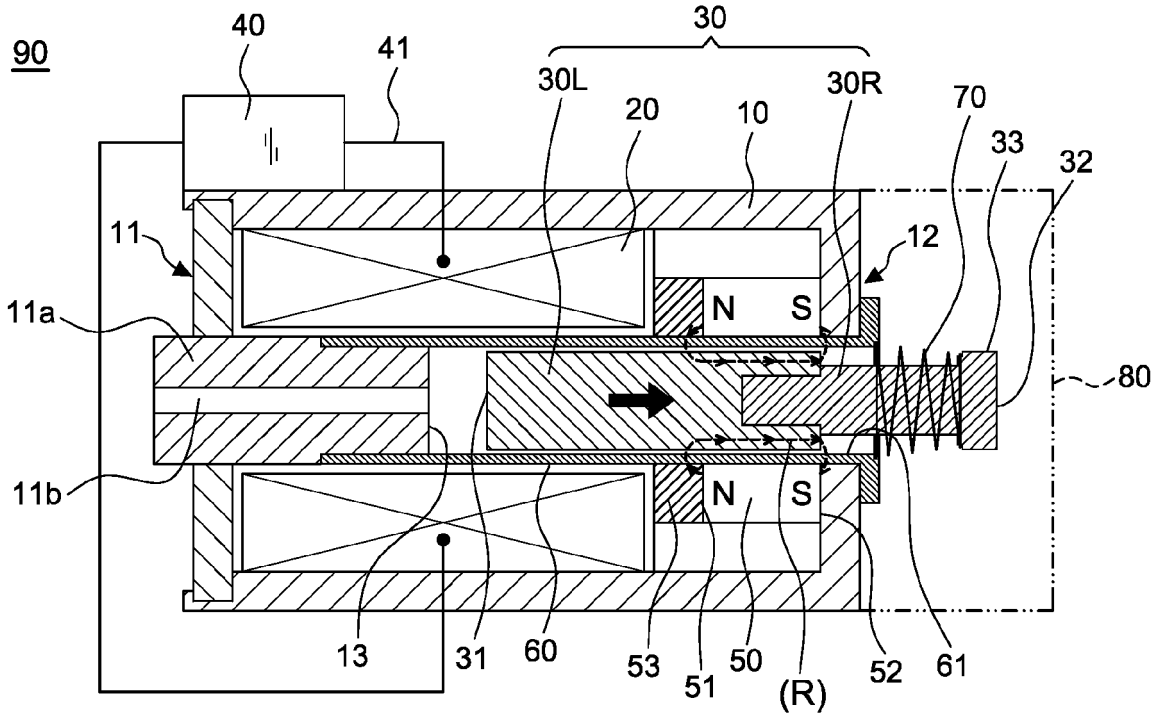


FIG.1B
PRIOR ART


90
40
41
30
30L
20
10
30R
70
33
32
11
12
11a
N
S
80
11b
N
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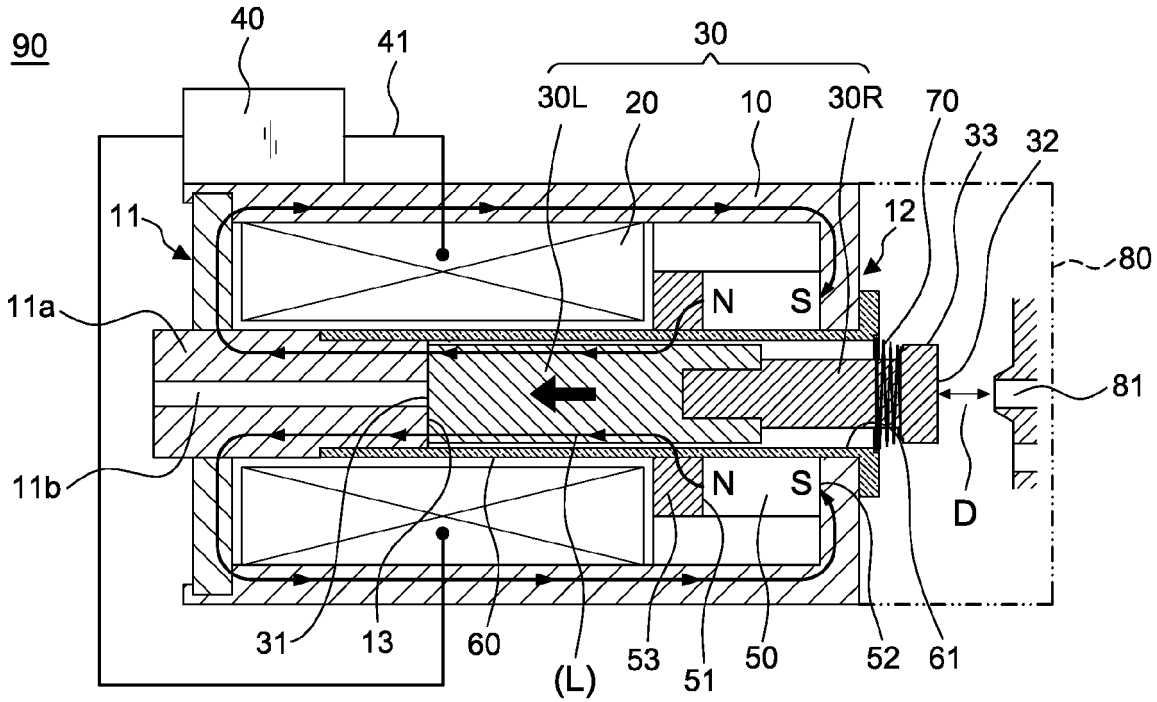
13
31
60
53
51
50
(R)
52
61

FIG.2A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41
30
30L
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10
30R
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33
32
11
12
80
11a
N
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81
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60
(L)
53
51
50
52
61

FIG.2B

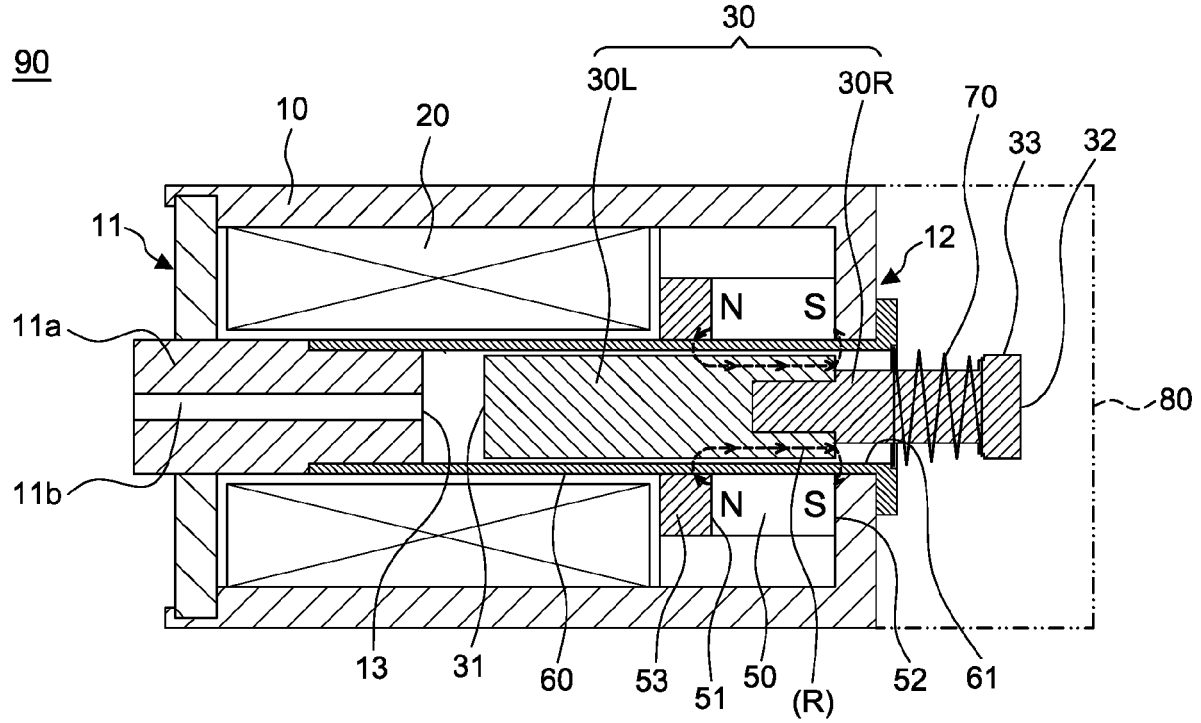
90
30
30L
30R
10
20
70
33
32
11
12
11a
N
S
80
11b
N
S
13
31
60
53
51
50
(R)
52
61

FIG.3A

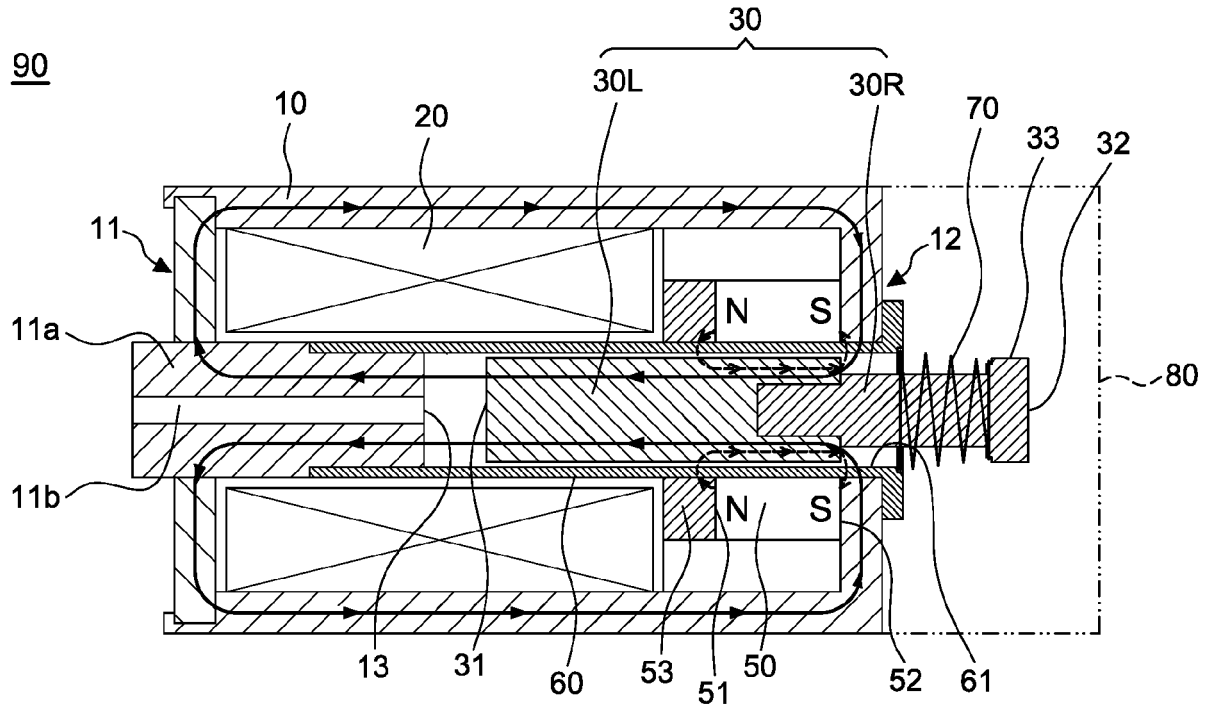
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FIG.3B

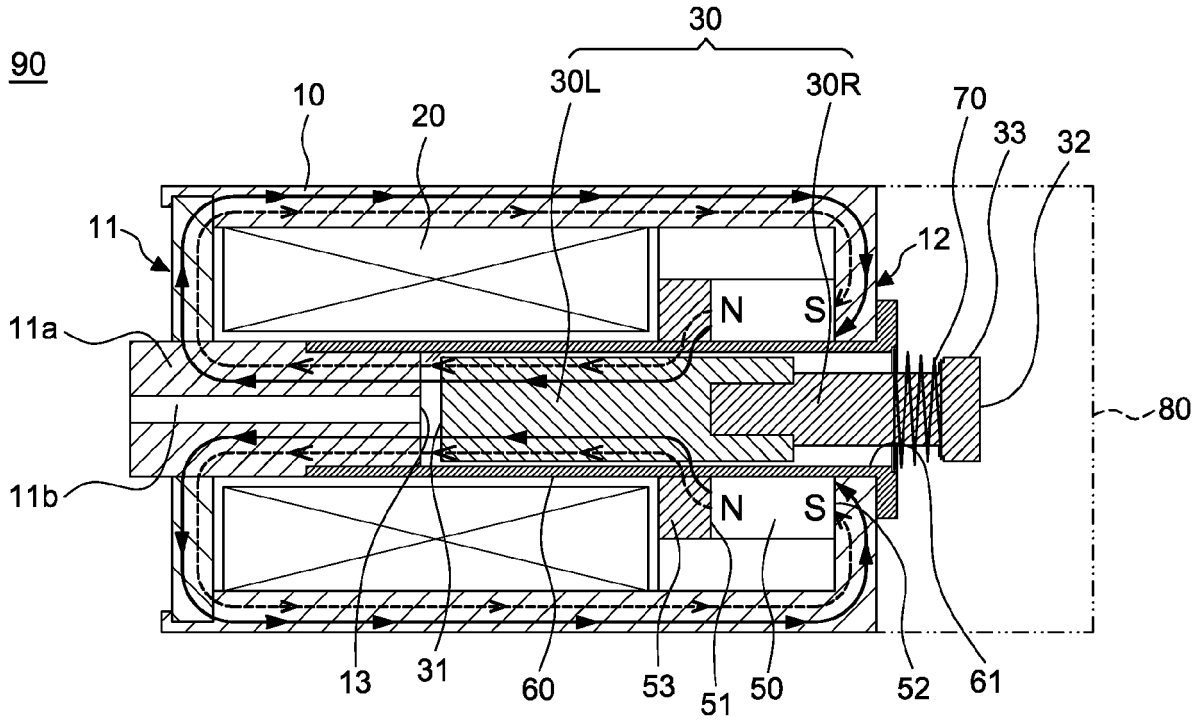
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FIG.3C

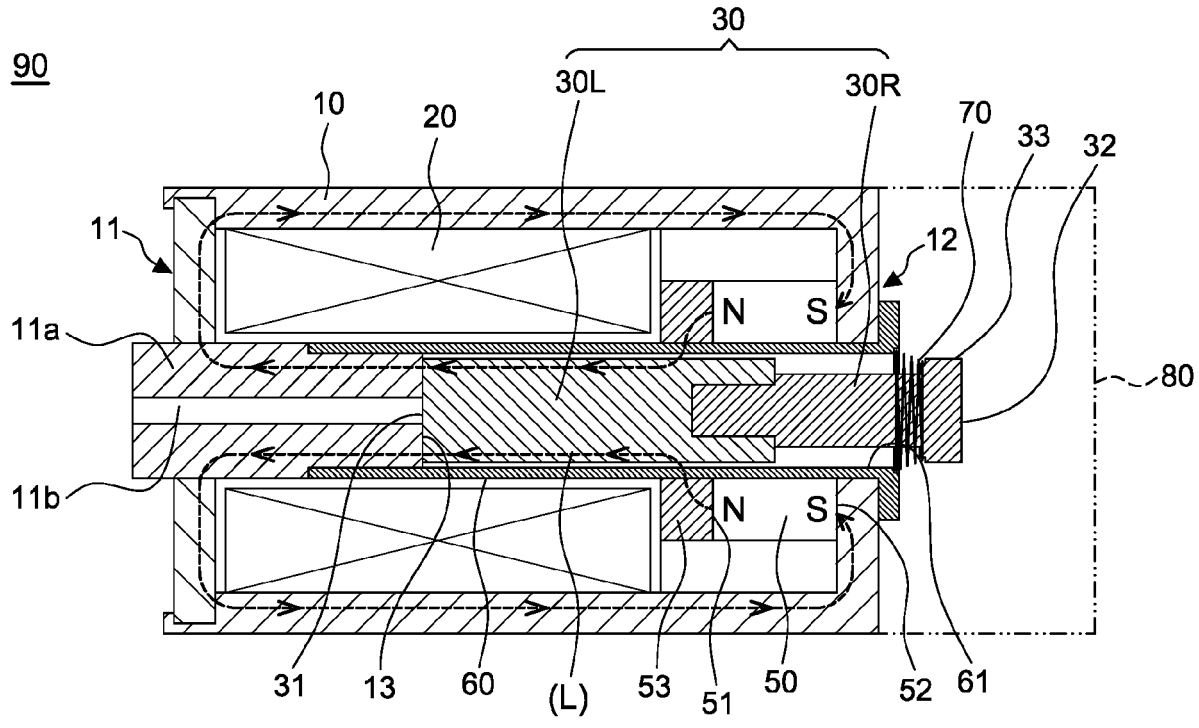
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FIG.3D

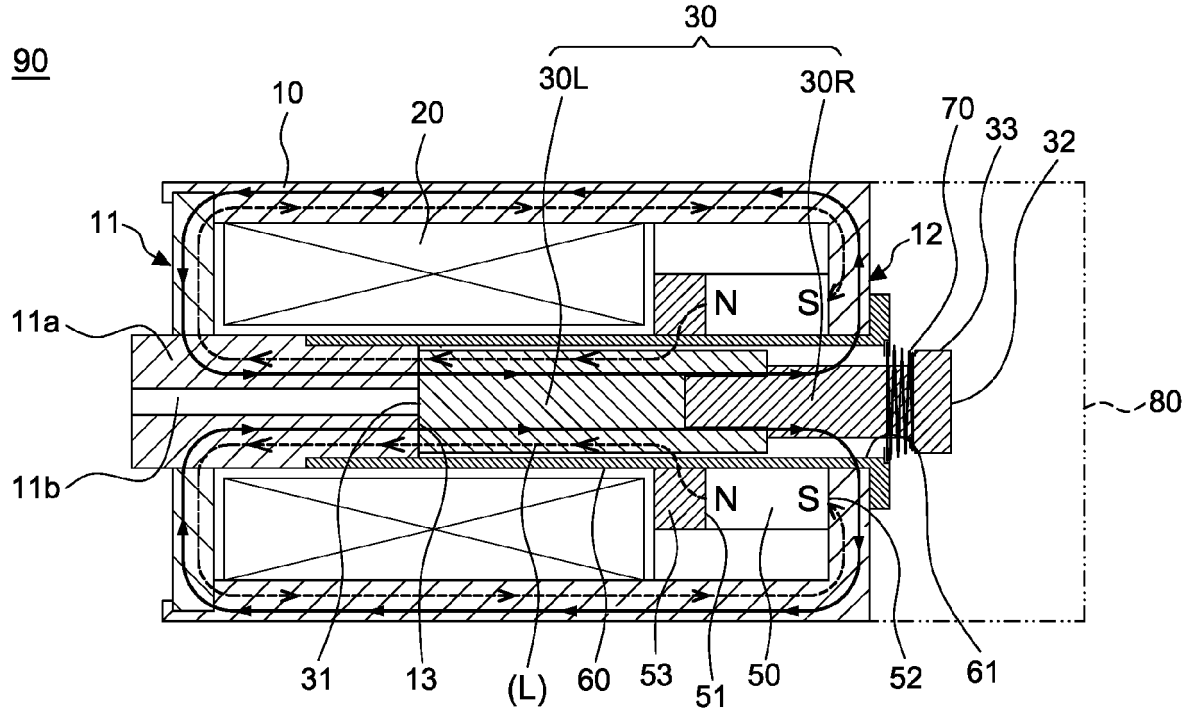
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FIG.3E

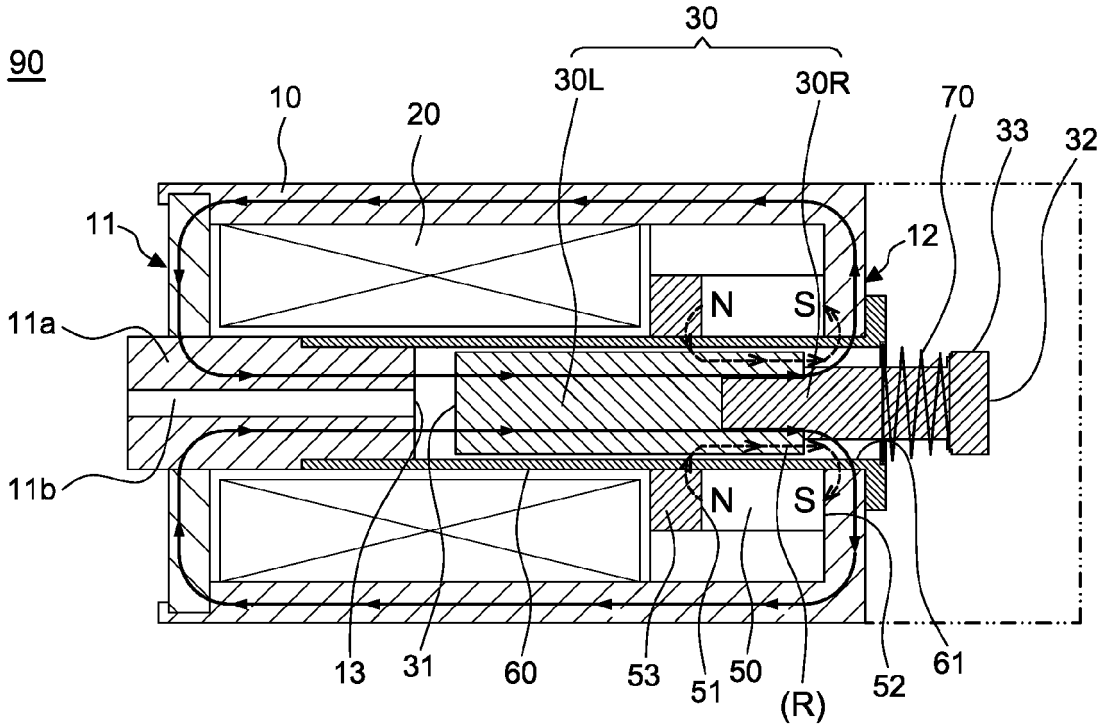
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FIG.3F

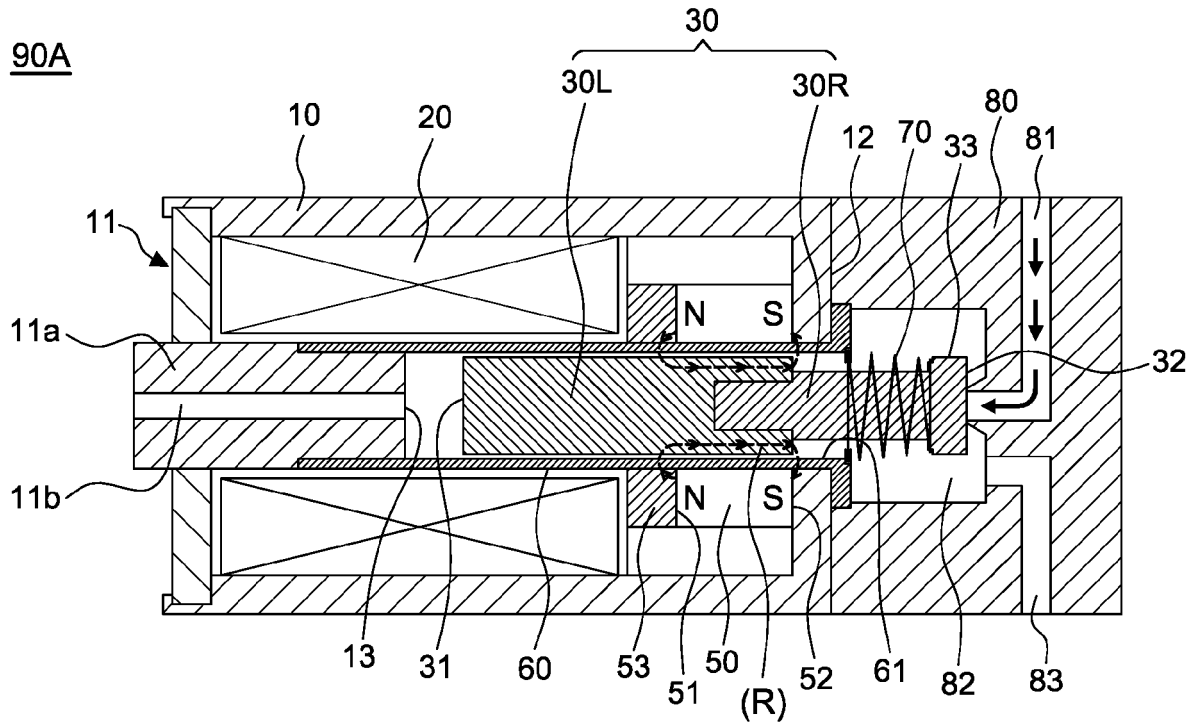
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FIG.4A

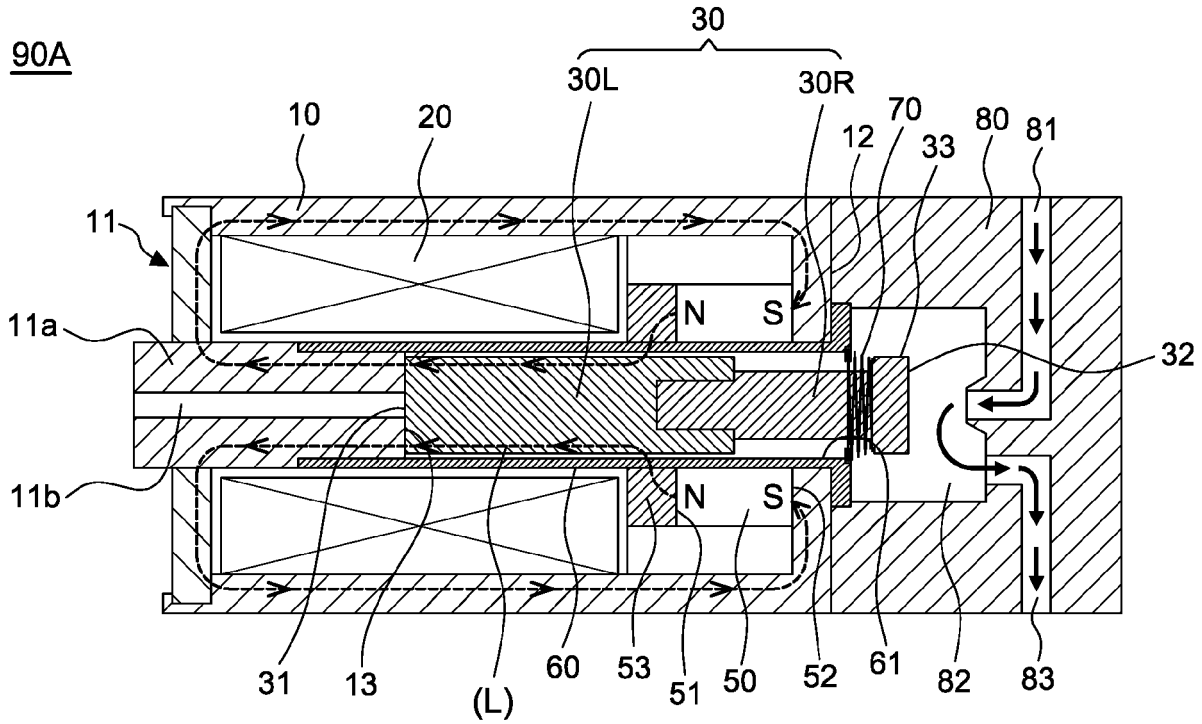
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FIG.4B

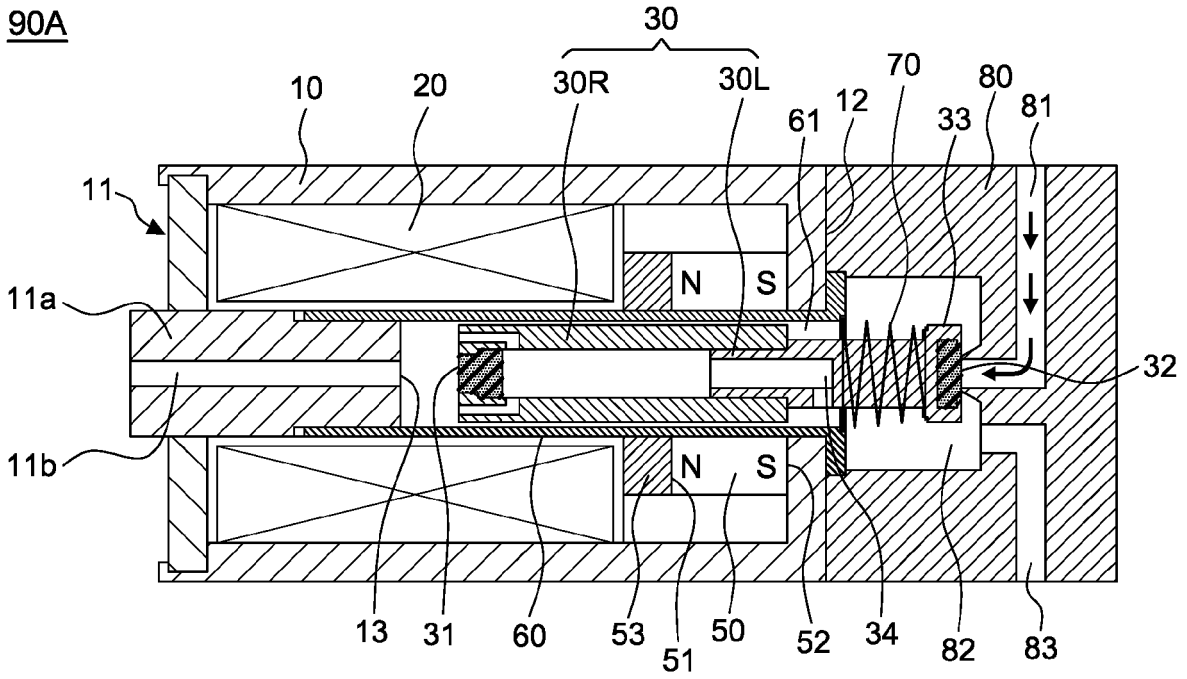
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FIG.5A

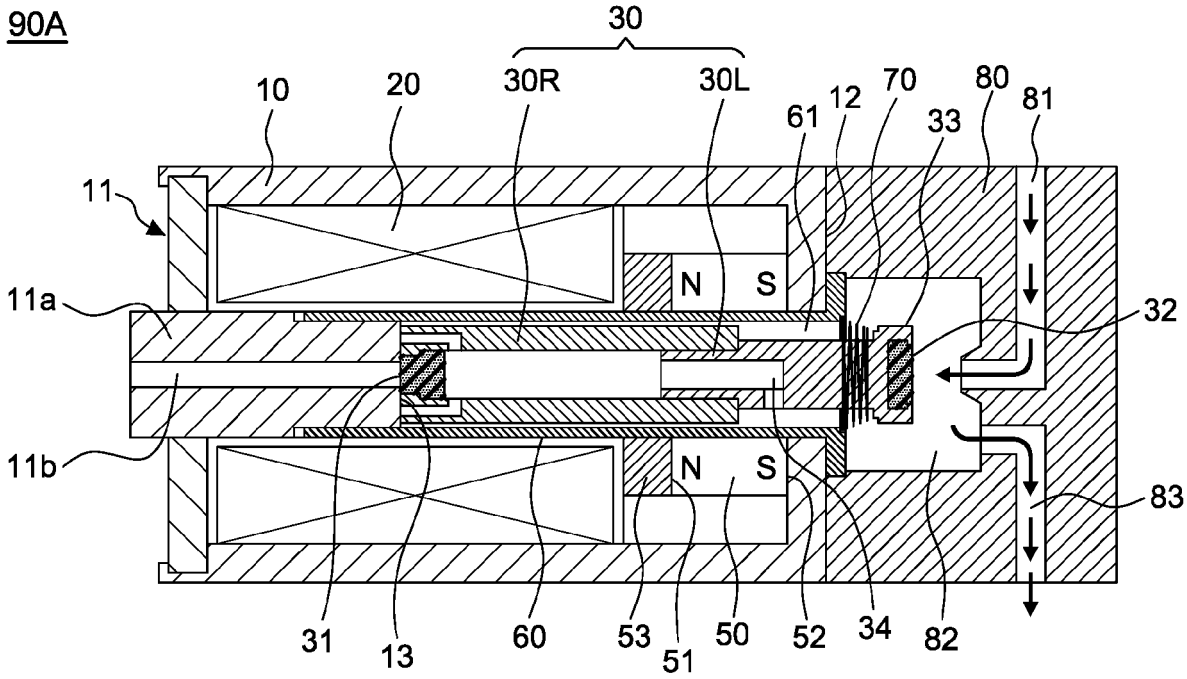
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FIG.5B

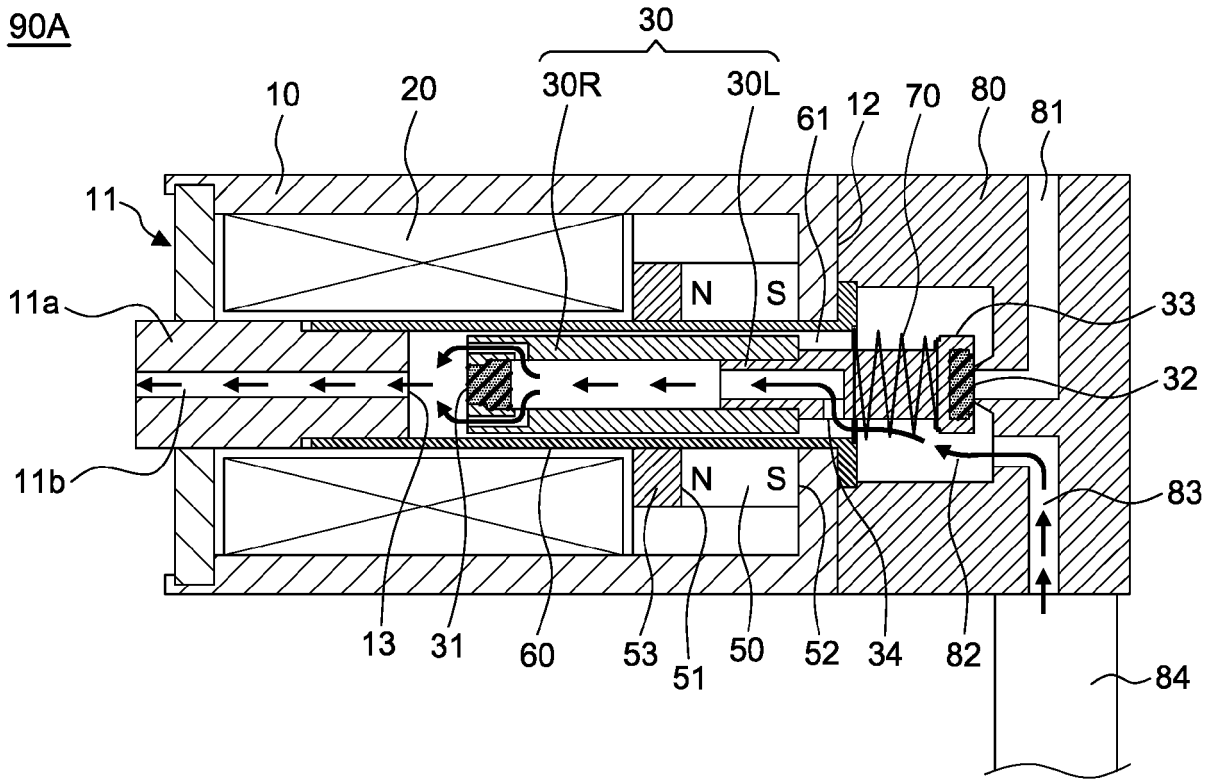
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FIG.5C

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EUROPEAN SEARCH REPORT

Application Number
EP 15 19 8358

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H01F
F16K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 June 2016	Gols, Jan

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