US Patent & Trademark Office
Patent Public Search | Text View

United States Patent	12387895
Kind Code	B2
Date of Patent	August 12, 2025
Inventor(s)	Yoo; Jung Woo et al.

Arc path formation unit and direct current relay including same

Abstract

Disclosed are an arc path forming part and a direct current relay including the same. An arc path forming part according to an embodiment of the present disclosure comprises a plurality of magnet parts. Each magnet part is located on one side and the other side of the arc path forming part, respectively, to form a magnetic field inside an arc chamber. The arc generated inside the arc chamber is extended in a direction away from the center of the arc chamber by receiving electromagnetic force from the magnetic field. Thus, damage to each component located at the center can be prevented.

Inventors:	**Yoo; Jung Woo (Anyang-si, KR), Kim; Han Mi Ru (Anyang-si, KR)**
Applicant:	**LS ELECTRIC CO., LTD.** (Anyang-si, KR)
Family ID:	**1000008751354**
Assignee:	**LS ELECTRIC CO., LTD. (Anyang-si, KR)**
Appl. No.:	**18/034632**
Filed (or PCT Filed):	**October 27, 2021**
PCT No.:	**PCT/KR2021/015221**
PCT Pub. No.:	**WO2022/092808**
PCT Pub. Date:	May 05, 2022

Prior Publication Data

Document Identifier	Publication Date
US 20230411096 A1	Dec. 21, 2023

Foreign Application Priority Data

KR	10-2020-0141512	Oct. 28, 2020

Publication Classification

Int. Cl.: **H01H50/38** (20060101); **H01H50/54** (20060101)

U.S. Cl.:

CPC **H01H50/38** (20130101); **H01H50/54** (20130101);

Field of Classification Search

USPC: None

References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2011/0240603	12/2010	Hoffmann	218/26	H01H 9/443
2012/0175344	12/2011	Tachikawa	218/26	H01H 9/443
2012/0175345	12/2011	Tachikawa	218/26	H01H 9/443
2012/0181860	12/2011	Hsu	218/24	H01H 9/443
2015/0042424	12/2014	Maruyama et al.	N/A	N/A

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
210467722	12/2019	CN	N/A
4174894	12/2022	EP	N/A
2016072020	12/2015	JP	N/A
2019036431	12/2018	JP	N/A
20160000079	12/2015	KR	N/A
102009875	12/2018	KR	N/A
20200103099	12/2019	KR	N/A
2011104902	12/2010	WO	N/A
2020094135	12/2019	WO	N/A

OTHER PUBLICATIONS

International Search Report for related International Application No. PCT/KR2021/015221; action dated May 5, 2022; (5 pages). cited by applicant

Written Opinion for related International Application No. PCT/KR2021/015221; action dated May 5, 2022; (10 pages). cited by applicant

Extended European Search Report for related European Application No. 21886802.4; action dated Sep. 16, 2024; (7 pages). cited by applicant

Primary Examiner: Rojas; Bernard

Attorney, Agent or Firm: K&L Gates LLP

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

(1) The present application is a National Stage of International Application No. PCT/KR2021/015221 filed on Oct. 27, 2021, which claims priority to and the benefit of Korean Utility Model Application No. 10-2020-0141512, filed Oct. 28, 2020, the disclosures of which are incorporated herein by reference in its entirety.

FIELD

(2) The present disclosure relates to an arc path forming part and a direct current relay including the same and, more particularly, to an arc path forming part having a structure capable of effectively directing a generated arc to the outside, and a direct current relay including the same.

BACKGROUND

(3) A direct current relay is a device that transmits a mechanical drive or current signal using the principle of an electromagnet. The direct current relay is also called an electromagnetic switch, and is generally classified as an electrical circuit switching device.

(4) The direct current relay includes a fixed contact and a movable contact. The fixed contact is electrically connected to an external power source and load. The fixed contact and the movable contact may be in contact with each other or spaced apart from each other.

(5) By contact and separation between the fixed contact and the movable contact, applying electric current through the direct current relay is allowed or blocked. The movement is achieved by a driving unit that applies a driving force to the movable contact.

(6) When the fixed contact and the movable contact are spaced apart, an arc is generated between the fixed contact and the movable contact. An arc is a flow of high-voltage, high-temperature current. Therefore, the generated arc must be quickly discharged from the direct current relay through a predetermined path.

(7) The discharge path of the arc is formed by a magnet provided in the direct current relay. The magnet forms a magnetic field inside a space where the fixed contact and the movable contact is in contact with each other. The discharge path of the arc may be formed by the electromagnetic force generated by the formed magnetic field and current flow.

(8) Referring to FIG. **1**, a space in which a fixed contact **1100** and a movable contact **1200** provided in a direct current relay **1000** according to the related art come into contact is shown. As described above, a permanent magnet **1300** is provided in the space.

(9) The permanent magnet **1300** includes a first permanent magnet **1310** positioned at an upper side and a second permanent magnet **1320** positioned at a lower side.

(10) A plurality of first permanent magnets **1310** are provided, and the polarity of each surface thereof facing the second permanent magnet **1320** is magnetized to a different polarity. The lower side of the first permanent magnet **1310** positioned on the left side of FIG. **1** is magnetized to N pole, and the lower side of the second permanent magnet **1320** positioned on the right side of FIG. **1** is magnetized to S pole.

(11) In addition, a plurality of second permanent magnets **1320** are also provided, and the polarity of each surface thereof facing the first permanent magnet **1310** is magnetized to a different polarity. The upper side of the second permanent magnet **1320** positioned on the left side of FIG. **1** is magnetized to S pole, and the upper side of the second permanent magnet **1320** positioned on the right side of FIG. **1** is magnetized to N pole.

(12) FIG. **1**(*a*) shows a state in which electric current flows in through the fixed contact **1100** on the left side and flows out through the fixed contact **1100** on the right side. According to Flemings left-hand rule, the electromagnetic force is formed like a hatched arrow.

(13) Specifically, in the case of the fixed contact **1100** located on the left side, the electromagnetic force is formed toward the outside. Accordingly, the arc generated at the corresponding location can be discharged to the outside.

(14) However, in the case of the fixed contact **1100** located on the right side, the electromagnetic

force is formed toward the inside, that is, toward the central portion of the movable contact **1200**. Accordingly, the arc generated at the corresponding location cannot be immediately discharged to the outside.
(15) In addition, FIG. **1**(*h*) shows a state in which electric current flows in through the fixed contact **1100** on the right side and flows out through the fixed contact **1100** on the left side. According to Flemings left-hand rule, the electromagnetic force is formed like a hatched arrow.
(16) Specifically, in the case of the fixed contact **1100** located on the right side, the electromagnetic force is formed toward the outside. Accordingly, the arc generated at the corresponding location can be discharged to the outside.
(17) However, in the case of the fixed contact **1100** located on the left side, the electromagnetic force is formed toward the inside, that is, toward the central portion of the movable contact **1200**. Accordingly, the arc generated at the corresponding location cannot be immediately discharged to the outside.
(18) Several members for driving the movable contact **1200** in the vertical direction are provided in the central portion of the direct current relay **1000**, that is, in the space between each fixed contact **1100**. For example, a shaft, a spring member inserted through the shaft, and the like are provided at the above position.
(19) Therefore, if the arc generated as shown in FIG. **1** is moved toward the central portion, and when the arc moved to the central portion is not immediately moved to the outside, there is a concern that several members provided at the position may be damaged by the energy of the arc.
(20) In addition, as shown in FIG. **1**, the direction of the electromagnetic force formed inside the direct current relay **1000** according to the related art depends on the direction of the current applied to the fixed contact **1200**. That is, the position of the electromagnetic force formed in the inward direction among the electromagnetic forces generated at each fixed contact point **1100** is different according to the direction of the current.
(21) That is, the user must consider the direction of the current whenever using the direct current relay. This may cause inconvenience in use of the direct current relay. In addition, regardless of the user's intention, a situation in which the direction of the current applied to the direct current relay is changed due to inexperienced operation cannot be excluded.
(22) In this case, members provided in the central portion of the direct current relay may be damaged by the generated arc. Accordingly, the durability period of the direct current relay may be reduced, and safety accidents may occur.
(23) Korean Patent Registration No. 10-1696952 discloses a direct current relay. Specifically, it discloses a direct current relay with a structure capable of preventing movement of a movable contact by using a plurality of permanent magnets.
(24) However, although the direct current relay of the above structure can prevent movement of the movable contact by using a plurality of permanent magnets, there is a limitation in that there is no consideration for a method for controlling the direction of an arc discharge path.
(25) Korean Patent Registration No. 10-1216824 discloses a direct current relay. Specifically, it discloses a direct current relay with a structure capable of preventing any separation between a movable contact and a fixed contact by using a damping magnet.
(26) However, the direct current relay having the above structure only proposes a method for maintaining the contact state between the movable contact and the fixed contact. That is, there is a limitation in that a method for forming a discharge path of an arc generated when the movable contact and the fixed contact are separated is not proposed. (Patent Document 1) Korean Patent Registration No. 10-1696952 (2017, Jan. 16.) (Patent Document 2) Korean Patent Registration Na 10-1216824 (2012, Dec. 28.)

SUMMARY

(27) The present disclosure is directed to providing an arc path forming part having a structure capable of solving the above problems, and a direct current relay including the same.

(28) First, it is directed to providing an arc path forming part having a structure capable of quickly extinguishing and discharging an arc generated as the energized electric current is cut off, and a direct current relay including the same.
(29) In addition, it is directed to providing an arc path forming part having a structure capable of reinforcing the magnitude of force for directing a generated arc, and a direct current relay including the same.
(30) In addition, it is directed to providing an arc path forming part having a structure capable of preventing damage to components for energizing electric current due to a generated arc, and a direct current relay including the same.
(31) In addition, it is directed to providing an arc path forming part having a structure in which arcs generated at a plurality of locations can proceed without meeting each other, and a direct current relay including the same.
(32) In addition, it is directed to providing an arc path forming part having a structure capable of achieving the above objects without excessive design change, and a direct current relay including the same.
(33) To achieve the above objects, the present disclosure provides an arc path forming part, comprising: a magnet frame comprising a space part for accommodating an arc chamber and a plurality of surfaces surrounding the space part; a first magnet part accommodated in the space part and comprising a magnet part disposed on at least one of the plurality of surfaces of the magnet frame, wherein the magnet part is positioned adjacent to one surface of the plurality of surfaces; and a second magnet part positioned adjacent to the other one surface of the plurality of surfaces facing the first magnet part with the space part interposed therebetween, wherein the first magnet part includes a plurality of magnet blocks disposed side by side in a direction in which the one surface extends, each inner surface thereof facing each other being magnetized to the same polarity, and wherein an inner surface of the second magnet part facing the first magnet part is magnetized to a polarity different from said polarity.
(34) In addition, the first magnet part of the arc path forming part may include a first magnet block that extends in a direction in which the one surface of the magnet frame extends, and is positioned to be biased to one side in the extending direction; and a second magnet block that extends in the same direction as the direction in which the first magnet block extends, and is positioned to be biased to the other side of the extending direction.
(35) In addition, the first magnet block and the second magnet block of the arc path forming part may be disposed spaced apart from each other.
(36) In addition, the second magnet part of the arc path forming part may extend in a direction in which the other one surface of the magnet frame extends.
(37) In addition, a magnetic intensity of the second magnet part of the arc path forming part may be greater than a magnetic intensity of any one of the plurality of magnet blocks of the first magnet part.
(38) In addition, the second magnet part of the arc path forming part may be an Nd magnet (Neodymium Magnet) or an NIB magnet (Neodymium-Iron-Boron Magnet).
(39) In addition, a fixed contact and a movable contact accommodated in the arc chamber may be positioned between the first magnet part and the second magnet part of the arc path forming part.
(40) In addition, the present disclosure provides an arc path forming part, comprising: a magnet frame comprising a space part for accommodating a fixed contact; a first magnet part comprising a magnet part accommodated in the space part, the magnet part being biased to one side of the space part; and a second magnet part positioned biased to the other side of the space part to face the first magnet part with the space part interposed therebetween, wherein the first magnet part includes a plurality of magnet blocks disposed side by side toward another other side and yet another other side opposite thereto, each inner surface facing each other and an inner surface facing the second magnet part are magnetized to the same polarity, and wherein an outer surface of the second

magnet part opposite to the space part is magnetized to the same polarity as said polarity.
(41) In addition, the first magnet part of the arc path forming part may include a first magnet block positioned biased to one of the another other side and the yet another other side and extending along the disposition direction; a second magnet block positioned biased to the other one of the another other side and the yet another other side and extending along the disposition direction; and a third magnet block positioned between the first magnet block and the second magnet block and extending along the disposition direction.
(42) In addition, an inner surface of the first magnet block facing the third magnet block and an inner surface of the second magnet block facing the third magnet block of the arc path forming part may be magnetized to the same polarity, and among surfaces of the third magnet block, an inner surface facing the second magnet part may be magnetized to the same polarity as each of the inner surfaces of the first magnet block and the second magnet block.
(43) In addition, the third magnet block of the arc path forming part may be in contact with the first magnet block and the second magnet block, respectively, so that the first magnet part is formed in a Halbach array.
(44) In addition, a magnetic intensity of the second magnet part of the arc path forming part may be greater than a magnetic intensity of any one of the plurality of magnet blocks of the first magnet part.
(45) In addition, the second magnet part of the arc path forming part may be an Nd magnet (Neodymium Magnet) or an NIB magnet (Neodymium-Iron-Boron Magnet).
(46) The second magnet part of the arc path forming part may include a first magnet unit positioned biased to one of the another other side and the yet another other side and extending along the disposition direction; and a second magnet unit positioned biased to the other one of the another other side and the yet another other side and extending along the disposition direction.
(47) In addition, an inner surface of surfaces of the first magnet unit facing the space part and an inner surface of surfaces of the second magnet unit facing the space part of the arc path forming part may be magnetized to the same polarity.
(48) Each of the inner surfaces of the plurality of magnet blocks of the first magnet part of the arc path forming part may be magnetized to a polarity different from that of each of the inner surfaces of the first magnet unit and the second magnet unit of the second magnet part.
(49) In addition, the present disclosure provides a direct current relay, comprising: a fixed contact electrically connected to an external power source and load; a movable contact coming into contact with and spaced apart from the fixed contact; an arc chamber for accommodating the fixed contact and the movable contact; and an arc path forming part that surrounds the arc chamber and directs an arc generated inside the arc chamber, wherein the movable contact has a length in one direction longer than a length in the other direction, wherein the arc path forming part includes: a first magnet part disposed spaced apart from the movable contact along the one direction on one side of the movable contact; and a second magnet part disposed on the other side of the movable contact and spaced apart from the movable contact along the one direction to face the first magnet part with the movable contact interposed therebetween, wherein the first magnet part comprises a plurality of magnet blocks disposed side by side along the other direction and having inner surfaces facing each other magnetized to the same polarity, and wherein an inner surface of the second magnet part facing the first magnet part is magnetized to a polarity different from said polarity.
(50) In addition, the present disclosure provides a direct current relay, comprising: a fixed contact electrically connected to an external power source and load; a movable contact coming into contact with and spaced apart from the fixed contact; and an arc path forming part in which a space part for accommodating the fixed contact and the movable contact is formed therein, wherein the arc path forming part includes: a pair of surfaces partially surrounding the space part and disposed to face each other; a first magnet part disposed adjacent to one of the pair of surfaces in the space part; and a second magnet part disposed adjacent to the other one of the pair of surfaces in the space part,

wherein the first magnet part includes a plurality of magnet blocks disposed side by side along a direction in which one of the surfaces extends, each inner surface facing each other and an inner surface facing the second magnet part being magnetized to the same polarity, and wherein an inner surface of the second magnet part facing the first magnet parts magnetized to a polarity different from said polarity.
(51) In addition, the present disclosure provides a direct current relay, comprising: a fixed contact electrically connected to an external power source and load; a movable contact coming into contact with and spaced apart from the fixed contact; and an arc path forming part in which a space part for accommodating the fixed contact and the movable contact is formed therein, wherein the arc path forming part includes: a pair of surfaces surrounding a portion of the space part and disposed to face each other; another pair of surfaces surrounding the remaining portion of the space part, being continuous with the pair of surfaces, and disposed to face each other; a first magnet part disposed adjacent to one of the pair of surfaces in the space part; and a second magnet part disposed adjacent to the other one of the pair of surfaces in the space part, wherein the first magnet part comprises a plurality of magnet blocks disposed side by side along a direction in which one of the surfaces extends, each inner surface facing each other and an inner surface facing the second magnet part being magnetized to the same polarity, and wherein the second magnet part comprises a plurality of magnet units disposed side by side along a direction in which the other surface extends, each inner surface facing each other being magnetized to a polarity different from said polarity.
(52) According to an embodiment of the present disclosure, the following effects can be achieved.
(53) First, the arc path forming part includes a plurality of magnet parts. Each magnet part is disposed to surround the space part inside the arc path forming part at different positions. Each magnet part forms a magnetic field inside the arc path forming part, respectively. The formed magnetic field forms an electromagnetic force together with a electric current energized in the fixed contact and the movable contact accommodated in the arc path forming part.
(54) In this case, the generated arc is formed in a direction away from each fixed contact. An arc generated when the fixed contact and the movable contact are separated may be directed by the electromagnetic force.
(55) Accordingly, the generated arc can be quickly extinguished and discharged to the outside of the arc path forming part and the direct current relay.
(56) Also, in various embodiments, each magnet part may include a plurality of magnet blocks or a plurality of magnet units. In an embodiment in which a plurality of magnet blocks or a plurality of magnet units are provided, the intensity of the magnetic field formed by each magnet part may be enhanced.
(57) Likewise, as the plurality of magnet blocks or the plurality of magnet units are provided, the intensity of the magnetic field formed between the plurality of magnet parts may also be enhanced. That is, the intensity of the magnetic field formed inside the space part can be enhanced by the configuration of each magnet part.
(58) Accordingly, the intensity of the electromagnetic force that depends on the intensity of the magnetic field can also be enhanced. As a result, the intensity of the electromagnetic force directing the generated arc is enhanced, so that the generated arc can be effectively extinguished and discharged.
(59) In addition, the direction of the electromagnetic force formed by the magnetic field formed by each magnet part and the electric current energized in the fixed contact and the movable contact is formed in a direction away from the central portion.
(60) In particular, in various embodiments, the direction of the electromagnetic force may be formed toward the corner of the arc chamber so as to be opposite to the central portion.
(61) Furthermore, since the intensity of the magnetic field and electromagnetic force is enhanced by each magnet part as described above, the generated arc can be extinguished and moved quickly in a direction away from the central portion.

(62) Therefore, damage to various components provided adjacent to the central portion for the operation of the direct current relay can be prevented.
(63) Also, in various embodiments, a plurality of fixed contacts can be provided. Each magnet part provided in the arc path forming part forms magnetic fields in different directions in the vicinity of each fixed contact. Therefore, paths of arcs generated in the vicinity of each fixed contact proceed in different directions.
(64) Therefore, the arcs generated in the vicinity of each fixed contact do not meet each other. Accordingly, malfunctions or safety accidents or the like that may occur due to collisions of arcs generated at different locations can be prevented.
(65) In addition, in order to achieve the above objects and effects, the arc path forming part includes each magnet part provided in the space part. In various embodiments, each magnet part can be located inside each surface of the magnet frame surrounding the space part.
(66) That is, a separate design change for disposing each magnet part outside the space part is not required.
(67) Therefore, the arc path forming part according to various embodiments of the present disclosure can be provided in the direct current relay without excessive design change. Accordingly, time and cost for applying the arc path forming part according to various embodiments of the present disclosure can be reduced.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is a conceptual diagram illustrating a direct current relay according to the related art.
(2) FIG. **2** is a perspective view illustrating a direct current relay according to an exemplary embodiment of the present disclosure.
(3) FIG. **3** is a cross-sectional view illustrating the configuration of the direct current relay of FIG. **2**.
(4) FIG. **4** is an open perspective view illustrating an arc path forming part provided in the direct current relay of FIG. **2**.
(5) FIGS. **5** and **6** are plan views illustrating an arc path forming part according to an exemplary embodiment of the present disclosure,
(6) FIGS. **7** to **10** are conceptual views illustrating arc paths formed by the arc path forming part according to the exemplary embodiment of FIGS. **5** and **6**.
(7) FIGS. **11** and **12** are plan views illustrating an arc path forming part according to another exemplary embodiment of the present disclosure.
(8) FIGS. **13** to **16** are conceptual views illustrating arc paths formed by the arc path forming part according to the exemplary embodiment of FIGS. **11** and **12**.
(9) FIGS. **17** and **18** are plan views illustrating an arc path forming part according to yet another exemplary embodiment of the present disclosure.
(10) FIGS. **19** to **22** are conceptual views illustrating arc paths formed by the arc path forming part according to the exemplary embodiment of FIGS. **17** and **18**.
DETAILED DESCRIPTION
(11) Hereinafter, an arc path forming part **100**, **200** or **300** and a direct current relay **1** including the same according to the embodiment of the present disclosure will be described in detail with reference to the accompanying drawings.
(12) In the following description, in order to clarify the features of the present disclosure, descriptions of some components may be omitted.
1. Term Definition
(13) When an element is referred to as being “connected” or “linked” to other element, it will be

understood that it can be directly connected or linked to the other element but intervening elements may also be present.
(14) On the other hand, when an element is referred to as being “directly connected” or “directly linked” to other element, it will be understood that there are no intervening elements present.
(15) As used herein, expressions in the singular include plural expressions unless the context clearly indicates otherwise.
(16) The term “magnetize” used in the following description means a phenomenon in Which an object becomes magnetic in a magnetic field.
(17) The term “polarity” used in the following description refers to different properties of an anode and a cathode of an electrode. In an embodiment, the polarity may be divided into N pole or S pole.
(18) The term “electric current” used in the following description means a state in which two or more members are electrically connected.
(19) The term “arc path (A.P)” used in the following description means a path along which a generated arc is moved or is extinguished and moved.
(20) “⊙” shown in the following figures means a flow in a direction in which the current flows from the movable contact **43** toward the fixed contact **22** (i.e., upward direction), that is, in a direction coming out of the ground.
(21) “.Math.” shown in the following figures means a flow in a direction in which the current flows from the fixed contact **22** toward the movable contact **43** downward direction), that is, a direction penetrating the ground.
(22) The term “Halbach array” used in the following description refers to an aggregate composed of a column or a row by arranging a plurality of magnetic materials side by side.
(23) A plurality of magnetic materials constituting the Halbach array may be arranged according to a predetermined rule. A plurality of magnetic materials may form a magnetic field by themselves or between each other.
(24) The Halbach array includes two relatively long surfaces and two relatively short surfaces. The magnetic field formed by the magnetic material constituting the Halbach array may be formed with a stronger intensity on the outer side of any one of the two long surfaces.
(25) In the following description, it is described on the premise that the intensity of the magnetic field in the direction toward the space parts **115**, **215**, and **315** among the magnetic fields formed by the Halbach array is stronger.
(26) The term “magnet part” used in the following description refers to any type of object that is formed of a magnetic material and can form a magnetic field. In an embodiment, the magnet part may be provided with a permanent magnet or an electromagnet. It will be understood that the magnet part is a magnetic material different from the magnetic material forming the Halbach array, that is, provided separately from the Halbach array.
(27) The magnet part may form a magnetic field by itself or together with other magnetic materials.
(28) The magnet part may extend in one direction. The magnet part may be magnetized to different polarities of opposite ends in the one direction (i.e., have different polarities in the longitudinal direction). In addition, the magnet part may be magnetized to different polarities of opposite surfaces in the other direction different from the one direction (i.e., have different polarities in the width direction).
(29) The magnetic field formed by the arc path forming part **100**, **200**, or **300** according to an embodiment of the present disclosure is shown as a dotted line in each drawing.
(30) The terms “left side”, “right side”, “upper side”, “lower side”, “front side”, and “rear side” used in the following description will be understood with reference to the coordinate system shown in FIG. **2**.
2. Description of the Configuration of the Direct Current Relay **1** According to the Embodiment of the Present Disclosure
(31) Referring to FIGS. **2** to **4**, the direct current relay **1** according to the embodiment of the

present disclosure includes a frame part **10**, a switch part **20**, a core part **30**, and a movable contact part **40**.
(32) In addition, referring to FIGS. **5** to **22**, the direct current relay **1** according to the embodiment of the present disclosure includes an arc path forming part **100**, **200** or **300**.
(33) The arc path forming part **100**, **200**, or **300** may form a discharge path of the generated arc.
(34) Hereinafter, each configuration of the direct current relay **1** according to the embodiment of the present disclosure will be described with reference to the accompanying drawings, and the arc path forming part **100**, **200** or **300** will be separately described.
(35) The arc path forming parts **100**, **200**, and **300** according to various embodiments described below will be described on the premise that they are provided in a direct current relay **1**.
(36) However, it will be understood that the arc path forming parts **100**, **200**, and **300** may be applied to a type of device, such as electromagnetic contactor and electromagnetic switch, capable of energizing electric current or blocking electric current with the outside by contact and separation between the fixed contact and the movable contact.
(37) (1) Description of the Frame Part **10**
(38) The frame part **10** forms the outer side of the direct current relay **1**. A predetermined space is formed inside the frame part **10**. Various devices performing a function of applying or blocking electric current transferred from the outside by the direct current relay **1** may be accommodated in the space.
(39) That is, the frame part **10** functions as a kind of housing.
(40) The frame part **10** may be formed of an insulating material such as a synthetic resin. It is to prevent the inside and the outside of the frame part **10** from being arbitrarily electrically currented.
(41) The frame part **10** includes an upper frame **11**, a lower frame **12**, an insulating plate **13**, and a support plate **14**.
(42) The upper frame **11** forms an upper side of the frame part **10**. A predetermined space is formed inside the upper frame **11**.
(43) The switch part **20** and the movable contact part **40** may be accommodated in the inner space of the upper frame **11**. In addition, the arc path forming part **100**, **200** or **300** may be accommodated in the inner space of the upper frame **11**.
(44) The upper frame **11** may be coupled to the lower frame **12**. The insulating plate **13** and the support plate **14** may be provided in a space between the upper frame **11** and the lower frame **12**.
(45) A fixed contact **22** of the switch part **20** is positioned on one side of the upper frame **11**, that is, on the upper side in the illustrated embodiment. A portion of the fixed contact **22** may be exposed on the upper side of the upper frame **11**, and may be electrically connected to an external power source or load.
(46) To this end, a through hole through which the fixed contact **22** is through-coupled may be formed on the upper side of the upper frame **11**.
(47) The lower frame **12** forms a lower side of the frame part **10**. A predetermined space is formed inside the lower frame **12**. The core part **30** may be accommodated in the inner space of the lower frame **12**.
(48) The lower frame **12** may be coupled to the upper frame **11**. The insulating plate **13** and the support plate **14** may be provided in a space between the lower frame **12** and the upper frame **11**.
(49) The insulating plate **13** and the support plate **14** electrically and physically separate the inner space of the upper frame **11** and the inner space of the lower frame **12**.
(50) The insulating plate **13** is positioned between the upper frame **11** and the lower frame **12**. The insulating plate **13** electrically separates the upper frame **11** and the lower frame **12**. To this end, the insulating plate **13** may be formed of an insulating material such as a synthetic resin.
(51) By the insulating plate **13**, any electric current between the switch part **20**, the movable contact part **40**, and the arc path forming part **100**, **200** or **300** accommodated in the upper frame **11** and the core part **30** accommodated in the lower frame **12** may be prevented.

(52) A through hole (not shown) is formed at the center of the insulating plate **13**. A shaft **44** of the movable contact part **40** is through-coupled to the through hole (not shown) so as to be movable in the vertical direction.
(53) The support plate **14** is positioned below the insulating plate **13**. The insulating plate **13** may be supported by the support plate **14**.
(54) The support plate **14** is positioned between the upper frame **11** and the lower frame **12**.
(55) The support plate **14** physically separates the upper frame **11** and the lower frame **12**. In addition, the support plate **14** supports the insulating plate **13**.
(56) The support plate **14** may be formed of a magnetic material. Therefore, the support plate **14** may form a magnetic circuit together with a yoke **33** of the core part **30**. A driving force for moving the movable core **32** of the core part **30** toward the stationary core **31** may be formed by the magnetic circuit.
(57) A through hole (not shown) is formed at the center of the support plate **14**. The shaft **44** is through-coupled to the through hole (not shown) so as to be movable in the vertical direction.
(58) Accordingly, when the movable core **32** is moved in a direction toward the stationary core **31** or away from the stationary core **31**, the shaft **44** and the movable contact **43** connected to the shaft **44** may also be moved together in the same direction.
(59) (2) Description of the Switch Part **20**
(60) The switch part **20** allows or blocks energizing electric current according to the operation of the core part **30**. Specifically, the switch part **20** may allow or block energizing electric current by contracting or separating the fixed contact **22** and the movable contact **43**.
(61) The switch part **20** is accommodated in the inner space of the upper frame **11**. The switch part **20** may be electrically and physically separated from the core part **30** by the insulating plate **13** and the support plate **14**.
(62) The switch part **20** includes an arc chamber **21**, a fixed contact **22**, and a sealing member **23**.
(63) In addition, an arc path forming part **100**, **200**, or **300** may be provided outside the arc chamber **21**. The arc path forming part **100**, **200**, or **300** may form a magnetic field for forming an arc path A.P for an arc generated inside the arc chamber **21**. This will be described later in detail.
(64) The arc chamber **21** extinguishes an arc generated when the fixed contact **22** and the movable contact **43** are separated from each other in an inner space. Accordingly, the arc chamber **21** may be referred to as an “arc extinguishing part”.
(65) The arc chamber **21** hermetically accommodates the fixed contact **22** and the movable contact **43**. That is, the fixed contact **22** and the movable contact **43** are accommodated inside the arc chamber Therefore, an arc generated when the fixed contact **22** and the movable contact **43** are separated from each other does not arbitrarily leak to the outside.
(66) A gas for extinguishing may be filled in the arc chamber **21**. The gas for extinguishing allows the generated arc to be extinguished and discharged to the outside of the direct current relay **1** through a preset path. To this end, a communication hole (not shown) may be formed through a wall surrounding the inner space of the arc chamber **21**.
(67) The arc chamber **21** may be formed of an insulating material. In addition, the arc chamber **21** may be formed of a material having high pressure resistance and high heat resistance. This is due to the generated arc being the flow of high temperature and high pressure electrons. In an embodiment, the arc chamber **21** may be formed of a ceramic material.
(68) A plurality of through holes may be formed on the upper side of the arc chamber **21**. A fixed contact **22** is through-coupled to each of the through holes.
(69) In the illustrated embodiment, two fixed contacts **22** are provided, including a first fixed contact **22***a* and a second fixed contact **22***b*. Accordingly, two through holes may also be formed on the upper side of the arc chamber **21**.
(70) When the fixed contact **22** is through-coupled to the through hole, the through hole is sealed. That is, the fixed contact **22** is hermetically coupled to the through hole. Accordingly, the generated

arc is not discharged to the outside through the through hole.
(71) The lower side of the arc chamber **21** may be open. The insulating plate **13** and the sealing member **23** are in contact with the lower side of the arc chamber **21**. That is, the lower side of the arc chamber **21** is sealed by the insulating plate **13** and the sealing member **23**.
(72) Accordingly, the arc chamber **21** may be electrically and physically separated from the outer space of the upper frame **11**.
(73) The arc extinguished in the arc chamber **21** is discharged to the outside of the direct current relay **1** through a preset path. In an embodiment, the extinguished arc may be discharged to the outside of the arc chamber **21** through the communication hole (not shown).
(74) The fixed contact **22** is in contact with or separated from the movable contact **43** to apply or block internal and external electric current energization of the direct current relay **1**.
(75) Specifically, when the fixed contact **22** is in contact with the movable contact **43**, the inside and outside of the direct current relay **1** pray be energizing electric current. On the other hand, when the fixed contact **22** is separated from the movable contact **43**, the electric current energization of the inside and outside of the direct current relay **1** may be blocked.
(76) As can be seen from the name, the fixed contact **22** is not moved. That is, the fixed contact is fixedly coupled to the upper frame **11** and the arc chamber **21**. Thus, the contact and separation of the fixed contact **22** and the movable contact **43** are achieved by the movement of the movable contact **43**.
(77) One end of the fixed contact **22**, that is, the upper end in the illustrated embodiment, is exposed to the outside of the upper frame **11**. A power source or a load is electrically connected to the one end.
(78) A plurality of fixed contacts **22** may be provided. In the illustrated embodiment, two fixed contacts **22** are provided, including a first fixed contact **22***a* on the left side and a second fixed contact **22***b* on the right side.
(79) The first fixed contact **22***a* is positioned to be biased to one side, that is, the left in the illustrated embodiment, from the center in the longitudinal direction of the movable contact **43**. In addition, the second fixed contact **22***b* is positioned to be biased to the other side, that is, the right in the illustrated embodiment, from the center in the longitudinal direction of the movable contact **43**.
(80) A power source may be electrically connected to any one of the first fixed contact **22***a* and the second fixed contact **22***b*. In addition, a load may be electrically connected to the other one of the first fixed contact **22***a* and the second fixed contact **22***h*.
(81) The direct current relay **1** according to an embodiment of the present disclosure may form an arc path A.P regardless of the direction of a power source or load connected to the fixed contact **22**. This is achieved by the arc path forming part **100**, **200**, or **300**, which will be described in detail later.
(82) The other end of the fixed contact **22**, that is, the lower end in the illustrated embodiment, extends toward the movable contact **43**.
(83) When the movable contact **43** is moved in a direction toward the fixed contact **22**, that is, upward in the illustrated embodiment, the lower end comes into contact with the movable contact **43**. Accordingly, the outside and the inside of the direct current relay **1** may be energizing electric current.
(84) The lower end of the fixed contact **22** is located inside the arc chamber **21**.
(85) When the control power is cut off, the movable contact **43** is spaced apart from the fixed contact **22** by an elastic force of a return spring **36**.
(86) In this case, as the fixed contact **22** and the movable contact **43** are spaced apart from each other, an arc is generated between the fixed contact **22** and the movable contact **43**. The generated arc may be extinguished by a gas for extinguishing inside the arc chamber **21** and may be discharged to the outside along a path formed by the arc path forming part **100**, **200**, or **300**.

(87) The sealing member **23** blocks any communication between the arc chamber **21** and a space inside the upper frame **11**. The sealing member **23** seals the lower side of the arc chamber **21** together with the insulating plate **13** and the support plate **14**.
(88) Specifically, the upper side of the sealing member **23** is coupled to the lower side of the arc chamber **21**. In addition, the radially inner side of the sealing member **23** is coupled to the outer circumference of the insulating plate **13**, and the lower side of the sealing member **23** is coupled to the support plate **14**.
(89) Accordingly, the arc generated in the arc chamber **21** and the arc extinguished by the gas for extinguishing do not arbitrarily leak into the inner space of the upper frame **11**.
(90) In addition, the sealing member **23** may be configured to block any communication between the inner space of the cylinder **37** and the inner space of the frame part **10**.
(91) (3) Description of the Core Part **30**
(92) The core part **30** moves the movable contact part **40** upward according to the application of the control power. In addition, when the application of the control power is released, the core part **30** moves the movable contact part **40** downward again.
(93) The core part **30** may be electrically connected to an external control power (not shown) to receive the control power.
(94) The core part **30** is located below the switch part **20**. In addition, the core part **30** is accommodated inside the lower frame **12**. The core part **30** and the switch part **20** may be electrically and physically separated from each other by the insulating plate **13** and the support plate **14**.
(95) The movable contact part **40** is positioned between the core part **30** and the switch part **20**. The movable contact part **40** may be moved by a driving force applied by the core part **30**. Accordingly, the movable contact **43** and the fixed contact **22** may be brought into contact with each other so that the direct current relay **1** may be energizing electric current.
(96) The core part **30** includes a stationary core **31**, a movable core **32**, a yoke **33**, a bobbin **34**, a coil **35**, a return spring **36**, and a cylinder **37**.
(97) The stationary core **31** is magnetized by a magnetic field generated in the coil **35** to generate an electromagnetic attraction force. By the electromagnetic attraction force, the movable core **32** is moved toward the stationary core **31** (upward direction in FIG. **3**).
(98) The stationary core **31** is not moved. That is, the stationary core **31** is fixedly coupled to the support plate **14** and the cylinder **37**.
(99) The stationary core **31** may be provided in any form capable of generating electromagnetic force by being magnetized by a magnetic field. In an embodiment, the stationary core **31** may be provided as a permanent magnet or an electromagnet and the like.
(100) The stationary core **31** is partially accommodated in an upper space inside the cylinder **37**. In addition, the outer circumference of the stationary core **31** is in contact with the inner circumference of the cylinder **37**.
(101) The stationary core **31** is located between the support plate **14** and the movable core **32**.
(102) A through hole (not shown) is formed at the center of the stationary core **31**. The shaft **44** is through-coupled to the through hole (not shown) so as to be movable up and down.
(103) The stationary core **31** is positioned to be spaced apart from the movable core **32** by a predetermined distance. Accordingly, the distance that the movable core **32** may be moved toward the stationary core **31** may be limited to the predetermined distance. Accordingly, the predetermined distance may be defined as “travel distance of the movable core **32**”.
(104) One end of the return spring **36**, that is, the upper end in the illustrated embodiment, is in contact with the lower side of the stationary core **31**. When the stationary core **31** is magnetized and the movable core **32** is moved upward, the return spring **36** is compressed and restoring force is stored.
(105) Accordingly, when the application of the control power is released and the magnetization of

the stationary core **31** is terminated, the movable core **32** may be returned to downward again by the restoring force.
(106) When the control power is applied, the movable core **32** is moved toward the stationary core **31** by electromagnetic attraction force generated by the stationary core **31**.
(107) As the movable core **32** is moved, the shaft **44** coupled to the movable core **32** is moved in the direction toward the stationary core **31**, that is, upward in the illustrated embodiment. In addition, as the shaft **44** is moved, the movable contact part **40** coupled to the shaft **44** is moved upward.
(108) Accordingly, the fixed contact **22** and the movable contact **43** may be brought into contact with each other so that the direct current relay **1** may be energizing electric current with an external power source or a load.
(109) The movable core **32** may be provided in any form capable of being subjected to attraction by electromagnetic force. In an embodiment, the movable core **32** may be formed of a magnetic material or may be provided as a permanent magnet or an electromagnet and the like.
(110) The movable core **32** is accommodated inside the cylinder **37**. In addition, the movable core **32** may be moved in the longitudinal direction of the cylinder **37** inside the cylinder **37**, that is, in a vertical direction in the illustrated embodiment.
(111) Specifically, the movable core **32** may be moved in a direction toward the stationary core **31** and in a direction away from the stationary core **31**.
(112) The movable core **32** is coupled to the shaft **44**. The movable core **32** may be moved integrally with the shaft **44**. When the movable core **32** is moved upward or downward, the shaft **44** is also moved upward or downward. Accordingly, the movable contact **43** is also moved upward or downward.
(113) The movable core **32** is located below the stationary core **31**. The movable core **32** is spaced apart from the stationary core **31** by a predetermined distance. The predetermined distance is the distance at which the movable core **32** may be moved in the vertical direction as described above.
(114) The movable core **32** is formed extending in the longitudinal direction. Inside the movable core **32**, a hollow part extending in the longitudinal direction is formed recessed by a predetermined distance. The lower part of the return spring **36** and the shaft **44** coupled through the return spring **36** are partially accommodated in the hollow part.
(115) A through hole is formed through the lower side of the hollow part in the longitudinal direction. The hollow part and the through hole communicate with each other. A lower end of the shaft **44** inserted into the hollow part may progress toward the through hole.
(116) At the lower end of the movable core **32**, a space part is formed recessed by a predetermined distance. The space part communicates with the through hole. The lower head portion of the shaft **44** is located in the space part.
(117) The yoke **33** forms a magnetic circuit as a control power is applied. The magnetic circuit formed by the yoke **33** may be configured to control the direction of the magnetic field formed by the coil **35**.
(118) Accordingly, when the control power is applied, the coil **35** may generate a magnetic field in a direction in which the movable core **32** is moved toward the stationary core **31**. The yoke **33** may be formed of a conductive material capable of energizing electric current.
(119) The yoke **33** is accommodated inside the lower frame **12**. The yoke **33** surrounds the coil **35**. The coil **35** may be accommodated inside the yoke **33** to be spaced apart from the inner circumferential surface of the yoke **33** by a predetermined distance.
(120) The bobbin **34** is accommodated inside the yoke **33**. That is, the yoke **33**, the coil **35**, and the bobbin **34** around which the coil **35** is wound are sequentially arranged in a radially inward direction from the outer circumference of the lower frame **12**.
(121) The upper side of the yoke **33** is in contact with the support plate **14**. In addition, the outer circumference of the yoke **33** may be positioned to contact the inner circumference of the lower

frame **12** or to be spaced apart from the inner circumference of the lower frame **12** by a predetermined distance.
(122) The coil **35** is wound around the bobbin **34**. The bobbin **34** is accommodated inside the yoke **33**.
(123) The bobbin **34** may include a flat plate-shaped upper portion and a flat plate-shaped lower portion, and a cylindrical pillar part extending in a longitudinal direction and connecting the upper portion and the lower portion. That is, the bobbin **34** has a bobbin shape.
(124) An upper portion of the bobbin **34** is in contact with a lower side of the support plate **14**. The coil **35** is wound around the pillar part of the bobbin **34**. The thickness of the coil **35** to be wound may be equal to or smaller than e diameters of the upper and lower portions of the bobbin **34**.
(125) A hollow part extending in the longitudinal direction is formed through the pillar part of the bobbin **34**. The cylinder **37** may be accommodated in the hollow part. The pillar part of the bobbin **34** may be arranged to have the same central axis as the stationary core **31**, the movable core **32**, and the shaft **44**.
(126) The coil **35** generates a magnetic field by an applied control power. The stationary core **31** may be magnetized by a magnetic field generated by the coil **35**, and an electromagnetic attraction force may be applied to the movable core **32**.
(127) The coil **35** is wound around the bobbin **34**. Specifically, the coil **35** is wound around the pillar part of the bobbin **34** and stacked radially outward of the pillar part. The coil **35** is accommodated inside the yoke **33**.
(128) When the control power is applied, the coil **35** generates a magnetic field. In this case, the intensity or direction or the like of the magnetic field generated by the coil **35** may be controlled by the yoke **33**. The stationary core **31** is magnetized by the magnetic field generated by the coil **35**.
(129) When the stationary core **31** is magnetized, the movable core **32** is subjected to an electromagnetic force, that is, an attraction force, in a direction toward the stationary core **31**, Accordingly, the movable core **32** is moved in a direction toward the stationary core **31**, that is, upward in the illustrated embodiment.
(130) The return spring **36** provides a restoring force for returning the movable core **32** to its original position when application of the control power is released after the movable core **32** is moved toward the stationary core **31**.
(131) As the movable core **32** is moved toward the stationary core **31** the return spring **36** is compressed and stores a restoring force. At this time, the stored restoring force is preferably smaller than the electromagnetic attraction force applied to the movable core **32** after the stationary core **31** is magnetized. This is to prevent the movable core **32** from being arbitrarily returned to its original position by the return spring **36** while the control power is applied.
(132) When the application of the control power is released, the movable core **32** receives a restoring force by the return spring **36**. Of course, gravity due to the empty weight of the movable core **32** may also act on the movable core **32**. Accordingly, the movable core **32** may be moved in a direction away from the stationary core **31** and returned to its original position.
(133) The return spring **36** may be provided in any shape capable of deforming, storing restoring force, returning to its original shape, and transmitting the restoring force to the outside. In an embodiment, the return spring **36** may be provided as a coil spring.
(134) A shaft **44** is coupled through the return spring **36**. The shaft **44** may be moved in the vertical direction regardless of the shape deformation of the return spring **36** in a state in which the return spring **36** is coupled.
(135) The return spring **36** is accommodated in a hollow part formed recessed on the upper side of the movable core **32**. In addition, one end of the return spring **36** facing the stationary core **31**, that is, the upper end in the illustrated embodiment, is accommodated in a hollow part formed recessed in the lower side of the stationary core **31**.
(136) The cylinder **37** accommodates the stationary core **31**, the movable core **32**, the return spring

36, and the shaft **44**. The movable core **32** and the shaft **44** may be moved upward and downward direction inside the cylinder **37**.
(137) The cylinder **37** is located in the hollow part formed in the pillar part of the bobbin **34**. The upper end of the cylinder **37** is in contact with the lower surface of the support plate **14**.
(138) The side surface of the cylinder **37** is in contact with the inner circumferential surface of the pillar part of the bobbin **34**. An upper opening of the cylinder **37** may be sealed by the stationary core **31**. The lower surface of the cylinder **37** may be in contact with the inner surface of the lower frame **12**,
(139) (4) Description of the Movable Contact Part **40**
(140) The movable contact part **40** includes the movable contact **43** and a configuration for moving the movable contact **43**. The direct current relay **1** may be energizing electric current with an external power source or a load by the movable contact part **40**.
(141) The movable contact part **40** is accommodated in the inner space of the upper frame **11**. In addition, the movable contact part **40** is accommodated in the arc chamber **21** to be movable vertically.
(142) The fixed contact **22** is positioned above the movable contact part **40**. The movable contact part **40** is accommodated in the arc chamber **21** to be movable in a direction toward the fixed contact **22** and in a direction away from the fixed contact **22**.
(143) A core part **30** is positioned below the movable contact part **40**. The movement of the movable contact part **40** may be achieved by the movement of the movable core **32**.
(144) The movable contact part **40** includes a housing **41**, a cover **42**, a movable contact **43**, a shaft **44** and an elastic part **45**.
(145) The housing **41** accommodates the movable contact **43** and the elastic part **45** elastically supporting the movable contact **43**.
(146) In the illustrated embodiment, one side of the housing **41** and the other side opposite thereto are open. A movable contact **43** may be inserted through the open portion.
(147) The open side surface of the housing **41** may be configured to surround the accommodated movable contact **43**.
(148) The cover **42** is provided on the upper side of the housing **41**. The cover **42** covers the upper surface of the movable contact **43** accommodated in the housing **41**.
(149) The housing **41** and the cover **42** are preferably formed of an insulating material to prevent unintentional electric current energization. In an embodiment, the housing **41** and the cover **42** may be formed of a synthetic resin or the like.
(150) The lower side of the housing **41** is connected to the shaft **44**. When the movable core **32** connected to the shaft **44** is moved upward or downward, the housing **41** and the movable contact **43** accommodated therein may also be moved upward or downward.
(151) The housing **41** and the cover **42** may be coupled by any member. In an embodiment, the housing **41** and the cover **42** may be coupled by a fastening member (not shown) such as a bolt or nut.
(152) The movable contact **43** comes into contact with the fixed contact **22** according to the application of control power, so that the direct current relay **1** is made energizing electric current with an external power supply and load. In addition, the movable contact **43** is separated from the fixed contact **22** when the application of control power is released, so that the direct current relay **1** is made not energizing electric current with an external power supply and load.
(153) The movable contact **43** is positioned adjacent to the fixed contact **22**.
(154) The upper side of the movable contact **43** is partially covered by the cover **42**. In an embodiment, a portion of the upper surface of the movable contact **43** may be in contact with the lower surface of the cover **42**.
(155) The lower side of the movable contact **43** is elastically supported by the elastic part **45**. To prevent the movable contact **43** from moving arbitrarily downward, the elastic part **45** may

elastically support the movable contact **43** in a compressed state by a predetermined distance.
(156) The movable contact **43** extends in the longitudinal direction, that is, left and right direction in the illustrated embodiment. That is, the length of the movable contact **43** is longer than the width. Accordingly, opposite ends in the longitudinal direction of the movable contact **43** accommodated in the housing **41** are exposed to the outside of the housing **41**.
(157) Contact protrusion portions protruding upward by a predetermined distance may be formed at the opposite ends. The fixed contact **22** is in contact with the contact protrusion portion.
(158) The contact protrusion portion may be formed at a position corresponding to each of the fixed contacts **22***a* and **22***b*. Accordingly, the moving distance of the movable contact **43** is reduced, and contact reliability between the fixed contact **22** and the movable contact **43** can be improved.
(159) The width of the movable contact **43** may be the same as the distance at which each side surface of the housing **41** is spaced apart from each other. That is, when the movable contact **43** is accommodated in the housing **41**, opposite side surfaces of the movable contact **43** in the width direction may contact inner surfaces of each side surface of the housing **41**.
(160) Accordingly, the state in which the movable contact **43** is accommodated in the housing **41** can be stably maintained.
(161) The shaft **44** transmits a driving force generated as the core part **30** is operated to the movable contact part **40**. Specifically, the shaft **44** is connected to the movable core **32** and the movable contact **43**. When the movable core **32** is moved upward or downward, the movable contact **43** may be also moved upward or downward by the shaft **44**.
(162) The shaft **44** extends in the longitudinal direction, that is, vertical direction in the illustrated embodiment.
(163) The lower end of the shaft **44** is inserted into and coupled to the movable core **32**. When the movable core **32** is moved in the vertical direction, the shaft **44** may be moved together with the movable core **32** in the vertical direction.
(164) The body part of the shaft **44** is coupled to the stationary core **31** so as to be movable up and down. The return spring **36** is coupled through the body part of the shaft **44**.
(165) The upper end of the shaft **44** is coupled to the housing **41**. When the movable core **32** is moved, the shaft **44** and the housing **41** may be moved together.
(166) Upper and lower ends of the shaft **44** may be formed to have larger diameters than the body part of the shaft. Accordingly, the shaft **44** may be stably coupled to the housing **41** and the movable core **32**.
(167) The elastic part **45** elastically supports the movable contact **43**. When the movable contact **43** comes into contact with the fixed contact **22**, the movable contact **43** tends to be spaced apart from the fixed contact **22** by electromagnetic repulsive force.
(168) At this time, the elastic part **45** elastically supports the movable contact **43** to prevent the movable contact **43** from being arbitrarily separated from the fixed contact **22**.
(169) The elastic part **45** may be provided in any form capable of storing a restoring force by deformation of a shape and providing the stored restoring force to other members. In an embodiment, the elastic part **45** may be provided as a coil spring.
(170) One end of the elastic part **45** facing the movable contact **43** is in contact with the lower side of the movable contact **43**. In addition, the other end opposite to the one end is in contact with the upper side of the housing **41**.
(171) The elastic part **45** may elastically support the movable contact **43** in a state in which a restoring force is stored after being compressed by a predetermined distance. Accordingly, even if an electromagnetic repulsive force is generated between the movable contact **43** and the fixed contact **22**, the movable contact **43** is not moved arbitrarily.
(172) For stable coupling of the elastic part **45**, a protrusion portion (not shown) inserted into the elastic part **45** may protrude from the lower side of the movable contact **43**, Similarly, a protrusion portion (not shown) inserted into the elastic part **45** may protrude from the upper side of the

housing **41**.

3. Description of the Arc Path Forming Parts **100**, **200**, and **300** According to an Embodiment of the Present Disclosure

(173) Referring to FIGS. **5** to **22**, path forming parts **100**, **200**, and **300** according to various embodiments of the present disclosure are illustrated. Each of the arc path forming parts **100**, **200**, and **300** forms a magnetic field inside the arc chamber **21**. An electromagnetic force is formed inside the arc chamber **21** by the electric current energizing through the direct current relay **1** and the formed magnetic field.

(174) An arc generated as the fixed contact **22** and the movable contact **43** are separated is moved out of the arc chamber **21** by the formed electromagnetic force. Specifically, the generated arc is moved along the direction of the formed electromagnetic force. Accordingly, it can be said that the arc path forming parts **100**, **200**, and **300** form an arc path A.P, which is a path through which the generated arc flows.

(175) The arc path forming part **100**, **200**, or **300** is located in a space formed inside the upper frame **11**. The arc path forming part **100**, **200**, or **300** is disposed surrounding the arc chamber **21**. In other words, the arc chamber **21** is located inside the arc path forming part **100**, **200**, or **300**.

(176) The fixed contact **22** and the movable contact **43** are positioned inside the arc path forming part **100**, **200**, or **300**. An arc generated when the fixed contact **22** and the movable contact **43** are separated may be directed by the electromagnetic force formed by the arc path forming part **100**, **200**, or **300**.

(177) The arc path forming parts **100**, **200**, and **300** according to various embodiments of the present disclosure include a Halbach array or a magnet part. The Halbach array or magnet part forms a magnetic field inside the arc path forming part **100** in which the fixed contact **22** and the movable contact **43** are accommodated. At this time, the Halbach array or magnet part may form a magnetic field by itself, and also between each other.

(178) The magnetic field formed by the Halbach array and the magnet part forms an electromagnetic force together with an electric current energizing through the fixed contact **22** and the movable contact **43**. The formed electromagnetic force directs an arc generated when the fixed contact **22** and the movable contact **43** are spaced apart.

(179) In this case, the arc path forming part **100**, **200**, or **300** forms an electromagnetic force in a direction away from the central portion C of the space part **115**, **215**, or **315**, Accordingly, the arc path A.P is also formed in a direction away from the central portion C of the space part.

(180) As a result, each component provided in the direct current relay **1** may not be damaged by the generated arc. Furthermore, the generated arc can be quickly discharged to the outside of the arc chamber **21**.

(181) Hereinafter, the configuration of each of the arc path forming parts **100**, **200**, **300** and the arc path A.P formed by each of the arc path forming parts **100**, **200**, **300** will be described in detail with reference to the accompanying drawings.

(182) The arc path forming parts **100**, **200**, and **300** according to various embodiments described below may have a Halbach array positioned on one or more sides of left and right sides.

(183) As will be described later, the rear side may be defined as a direction adjacent to the first surfaces **111**, **211**, and **311**, and the front side adjacent to the second surfaces **112**, **212**, and **312**.

(184) In addition, the left side may be defined as a direction adjacent to the third surfaces **113**, **213**, and **313**, and the right side adjacent to the fourth surfaces **114**, **214**, and **314**.

(185) (1) Description of Arc Path Forming Part **100** According to an Embodiment of the Present Disclosure

(186) Hereinafter, the arc path forming part **100** according to an embodiment of the present disclosure will be described in detail with reference to FIGS. **5** to **10**.

(187) Referring to FIGS. **5** to **6**, the arc path forming part **100** according to the illustrated embodiment includes a magnet frame **110**, a first magnet part **120** and a second magnet part **130**.

(188) The magnet frame **110** forms the frame of the arc path forming part **100**. The first and second magnet parts **120** and **130** are disposed on the magnet frame **110**. In an embodiment, the first and second magnet parts **120** and **130** may be coupled to the magnet frame **110**.
(189) The magnet frame **110** has a rectangular cross-section extending in the longitudinal direction, that is, left and right directions in the illustrated embodiment. The shape of the magnet frame **110** may be changed according to the shape of the upper frame **11** and the arc chamber **21**.
(190) The magnet frame **110** includes a first surface **111**, a second surface **112**, a third surface **113**, a fourth surface **114**, and a space part **115**.
(191) The first surface **111**, the second surface **112**, the third surface **113**, and the fourth surface **114** form an outer circumferential surface of the magnet frame **110**. That is, the first surface **111**, the second surface **112**, the third surface **113**, and the fourth surface **114** function as walls of the magnet frame **110**.
(192) The outer sides of the first surface **111**, the second surface **112**, the third surface **113**, and the fourth surface **114***b* may be in contact with or fixedly coupled to the inner surface of the upper frame **11**.
(193) In the illustrated embodiment, the first surface **111** forms a rear side surface. The second surface **112** forms a front side surface and is opposite to the first surface **111**. In addition, the third surface **113** forms a left side surface. The fourth surface **114** forms a right side surface and is opposite to the third surface **113**, That is, the first surface **111** and the second surface **112** face each other with the space part **115** interposed therebetween. In addition, the third surface **113** and the fourth surface **114** face each other with the space part **115** interposed therebetween.
(194) The first surface **111** is continuous with the third surface **113** and the fourth surface **114**. The first surface **111** may be coupled to the third surface **113** and the fourth surface **114** at a predetermined angle. In an embodiment, the predetermined angle may be a right angle.
(195) The second surface **112** is continuous with the third surface **113** and the fourth surface **114**. The second surface **112** may be coupled to the third surface **113** and the fourth surface **114** at a predetermined angle. In an embodiment, the predetermined angle may be a right angle.
(196) Each corner where the first surface **111** to the fourth surface **114** are connected to each other may be tapered.
(197) A fastening member (not shown) may be provided to couple the surfaces **111**, **112**, **113**, and **114** with the first and second magnet parts **120** and **130**.
(198) Although not illustrated, an arc discharge hole (not illustrated) may be formed through at least one of the first surface **111**, the second surface **112**, the third surface **113** and the fourth surface **114**. The arc discharge hole (not shown) may function as a passage through which the arc generated in the space part **115** is discharged.
(199) A space surrounded by the first surface **111** to the fourth surface **114** may be defined as the space part **115**.
(200) The fixed contact **22** and the movable contact **43** are accommodated in the space part **115**. In addition, the arc chamber **21** is accommodated in the space part **115**.
(201) In the space part **115**, the movable contact **43** may be moved in a direction toward the fixed contact **22** (i.e., a downward direction) or away from the fixed contact **22** (i.e., an upward direction).
(202) In addition, the path A.P of the arc generated in the arc chamber **21** is formed in the space part **115**. This is achieved by a magnetic field formed by the first and second magnet parts **120** and **130**.
(203) A central portion of the space part **115** may be defined as a central portion C. The straight line distance from each corner where the first to fourth surfaces **111**, **112**, **113**, and **114** are connected to each other to the central portion C may be the same.
(204) The central portion C is located between the first fixed contact **22***a* and the second fixed contact **22***h*. In addition, the center portion of the movable contact part **40** is positioned vertically

below the central portion C. That is, central portions of the housing **41**, the cover **42**, the movable contact **43**, the shaft **44**, the elastic part **45** or the like are positioned vertically below the central portion C.
(205) Accordingly, when the generated arc is moved toward the central portion C, damage to the components may occur. To prevent this, the arc path forming part **100** according to the present embodiment includes the first and second magnet parts **120** and **130**.
(206) The first magnet part **120** may form a magnetic field together with other magnetic materials. In the illustrated embodiment, the first magnet part **120** may form a magnetic field together with the second magnet part **130**.
(207) The first magnet part **120** may be positioned adjacent to one of the third and fourth surfaces **113** and **114**. In an embodiment, the first magnet part **120** may be coupled to an inner side (i.e., in a direction toward the space part **115**) of any one of the surfaces.
(208) In the embodiment shown in FIG. **5**, the first magnet part **120** is disposed inside the third surface **113** and adjacent to the third surface **113**, in the embodiment shown in FIG. **6**, the first magnet part **120** may be disposed inside the fourth surface **114** and adjacent to the fourth surface **114**.
(209) The first magnet part **120** is disposed to face the second magnet part **130**. In the embodiment shown in FIG. **5**, the first magnet part **120** is disposed to face the second magnet part **130** located inside the fourth surface **114**. In the embodiment shown in FIG. **6**, the first magnet part **120** is disposed to face the second magnet part **130** located inside the third surface **113**.
(210) The space part **115** and the fixed contact **22** and the movable contact **43** accommodated in the space part **115** are positioned between the first magnet part **120** and the second magnet part **130**.
(211) The first magnet part **120** may strengthen the intensity of the magnetic field formed by itself and the magnetic field formed together with the second magnet part **130**. Since the direction of the magnetic field formed by the first magnet part **120** and the process of strengthening the magnetic field are well-known techniques, a detailed description thereof will be omitted.
(212) In the illustrated embodiment, a plurality of magnetic materials constituting the first magnet part **120** are arranged side by side from the front side to the rear side. In addition, the plurality of magnetic materials constituting the first magnet part **120** extend in the front-rear direction.
(213) That is, the plurality of magnetic materials constituting the first magnet part **20** are arranged side by side in the extension direction.
(214) In the illustrated embodiment, the first magnet part **120** includes a first magnet block **121** and a second magnet block **122**. It will be understood that the plurality of magnetic materials constituting the first magnet part **120** are named magnet blocks **121** and **122**, respectively.
(215) The first and second magnet blocks **121** and **122** may be formed of a magnetic material. In an embodiment, the first and second magnet blocks **121** and **122** may be provided as permanent magnets or electromagnets or the like.
(216) The first and second magnet blocks **121** and **122** may be arranged side by side in one direction. In the illustrated embodiment, the first and second magnet blocks **121** and **122** are disposed side by side in a direction in which the third surface **113** extends, that is, in the front and rear direction.
(217) Among the first and second mag net blocks **121** and **122**, the first magnet block **121** is disposed on the rear side and the second magnet block **122** is disposed on the front side. In the illustrated embodiment, the first and second magnet blocks **121** and **122** are spaced apart from each other.
(218) In the above embodiment, the space in which the first and second magnet blocks **121** and **122** are spaced apart from each other may overlap the fixed contact **22** along the left-right direction, that is, along the direction in which the first surface **111** or the second surface **112** extends.
(219) Alternatively, the first and second magnet blocks **121** and **122** may be in contact with each other. In the above embodiment, it will be understood that the first magnet part **120** may function as

a Halbach array.
(220) The first and second magnet blocks **121** and **122** include a plurality of surfaces.
(221) Specifically, the first magnet block **121** includes a first inner surface **121***a* facing the second magnet block **122** and a first outer surface **121***b* opposite to the second magnet block **122**.
(222) The second magnet block **122** includes a second inner surface **122***a* facing the first magnet block **121** and a second outer surface **122***b* opposite to the first magnet block **121**.
(223) The plurality of surfaces of each of the magnet blocks **121** and **122** may be magnetized according to a predetermined rule.
(224) That is, the first inner surface **121***a* and the second inner surface **122***a* are magnetized to the same polarity. In addition, the first outer surface **121***b* and the second outer surface **122***b* are each magnetized to a polarity different from the above polarity.
(225) In this case, the first inner surface **121***a* and the second inner surface **122***a* may be magnetized to the same polarity as the first outer surface **131***b* of the second magnet part **130**. That is, the first inner surface **121***a* and the second inner surface **122***a* are magnetized to a polarity different from that of the first inner surface **131***a* of the second magnet part **130**.
(226) Likewise, the first outer surface **121***b* and the second outer surface **122***h* are magnetized to the same polarity as the first inner surface **131***a* of the second magnet part **130**. That is, the first inner surface **121***a* and the second inner surface **122***a* a magnetized to a polarity different from that of the first outer surface **131***b* of the second magnet part **130**.
(227) In the embodiments shown in (a) of FIG. **5** and (a) of FIG. **6**, the first inner surface **121***a* and the second inner surface **122***a* are each magnetized to the S pole. In the above embodiment, the first inner surface **131***a* of the second magnet part **130** is magnetized to the N pole different from the above polarity.
(228) In addition, in the embodiments shown in (b) of FIG. **5** and (h) of FIG. **6**, the first inner surface **121***a* and the second inner surface **122***a* are each magnetized to the N pole. In the above embodiment, the first inner surface **131***a* of the second magnet part **130** is magnetized to the S pole different from the above polarity.
(229) The second magnet part **130** may form a magnetic field together with other magnetic materials. In the illustrated embodiment, the second magnet part **130** may form a magnetic field together with the first magnet part **120**.
(230) The second magnet part **130** may be positioned adjacent to the other one of the third and fourth surfaces **113** and **114**. In an embodiment, the second magnet part **130** may be coupled to an inner side (i.e., in a direction toward the space part **115**) of the other one of the surfaces.
(231) In the embodiment shown in FIG. **5**, the second magnet part **130** is disposed inside the fourth surface **114** and adjacent to the fourth surface **114**. In the embodiment shown in FIG. **6**, the second magnet part **130** may be disposed inside the third surface **113** and adjacent to the third surface **113**.
(232) The second magnet part **130** is disposed to face the first magnet part **120** with the space part **115** interposed therebetween. In the embodiment shown in FIG. **5**, the second magnet part **130** is disposed to face the first magnet part **120** located inside the third surface **113**. In the embodiment shown in FIG. **6**, the second magnet part **130** is disposed to face the first magnet part **120** located inside the fourth surface **114**.
(233) The space part **115** and the fixed contact **22** and the movable contact **43** accommodated in the space part **115** are positioned between the second magnet part **130** and the first magnet part **120**.
(234) The second magnet part **130** may strengthen the intensity of the magnetic field formed by itself and the magnetic field formed together with the first magnet part **120**. Since the direction of the magnetic field formed by the second magnet part **130** and the process of strengthening the magnetic field are well-known techniques, a detailed description thereof will be omitted.
(235) In an embodiment, the second magnet part **130** may be formed to have stronger magnetism than each of the magnet blocks **121** and **122** constituting the first magnet part **120**. This is due to the fact that the number of magnet units provided in the second magnet part **130** is smaller than the

number of magnet blocks provided in the first magnet part **120**.
(236) In an embodiment, the second magnet part **130** may be provided as an Nd magnet (Neodymium Magnet) or an NIB magnet (Neodymium-Iron-Boron Magnet).
(237) In the illustrated embodiment, the second magnet part **130** includes a first magnet unit **131**. It will be understood that the magnetic material constituting the second magnet part **130** is named the magnet unit **131**.
(238) The first magnet unit **131** may be formed of a magnetic material. In an embodiment, the first magnet unit **131** may be provided as a permanent magnet or an electromagnet or the like.
(239) The first magnet unit **131** may extend in a direction in which the first magnet part **120** extends, that is, in the front and rear direction in the illustrated embodiment. In an embodiment, the first magnet unit **131** may extend by a length longer than each of the magnet blocks **121** and **122**.
(240) The first magnet unit **131** may be disposed to overlap each of the fixed contacts **22***a* and **22***b* in a direction toward the third surface **113**, that is, in the left and right directions in the illustrated embodiment. In other words, the first magnet unit **131** may be disposed to overlap the fixed contact **22** along the direction in which the first surface **111** or the second surface **112** extends.
(241) The first magnet unit **131** includes a plurality of surfaces.
(242) Specifically, the first magnet unit **131** includes a first inner surface **131***a* facing the space part **115** or the first magnet part **120** and a first outer surface **131***b* opposite to the space part **115** or the first magnet part **120**.
(243) The plurality of surfaces of the first magnet unit **131** may be magnetized according to a predetermined rule.
(244) The first inner surface **131***a* and the first outer surface **131***b* are magnetized to different polarities. In this case, the first inner surface **131***a* may be magnetized to the same polarity as each of the outer surfaces **121***b* and **122***b* of the first magnet part **120**. In other words, the first inner surface **131***a* may be magnetized to a polarity different from that of each of the inner surfaces **121***a* and **122***a* of the first magnet part **120**.
(245) Likewise, the first outer surface **131***b* may be magnetized to the same polarity as each of the inner surfaces **121***a* and **122***a* of the first magnet part **120**. In other words, the first outer surface **131***b* may be magnetized to a polarity different from that of each of the outer surfaces **121***b* and **122***b* of the first magnet part **120**.
(246) In the embodiments shown in (a) of FIG. **5** and (a) of FIG. **6**, the first inner surface **131***a* is magnetized to the N pole. In the above embodiment, the first inner surface **121***a* and the second inner surface **122***a* of the first magnet part **120** are each magnetized to the S pole.
(247) In addition, in the embodiments shown in (b) of FIG. **5** and (b) of FIG. **6**, the first inner surface **131***a* is magnetized to the S pole. In the above embodiment, the first inner surface **121***a* and the second inner surface **122***a* of the first magnet part **120** are each magnetized to the N pole.
(248) Accordingly, a magnetic field directed from one of the first magnet part **120** and the second magnet part **130** toward the other magnet part is formed in the space part **115**.
(249) Hereinafter, the arc path A.P formed by the arc path forming part **100** according to the present embodiment will be described in detail with reference to FIGS. **7** to **10**.
(250) Referring to FIGS. **7** and **9**, each of the inner surfaces **121***a* and **122***a* of the first magnet part **120** and the inner surface **131***a* of the second magnet part **130** are magnetized to different polarities.
(251) That is, each of the inner surfaces **121***a* and **122***a* of the first magnet part **120** is magnetized to the S pole, and the inner surface **131***a* of the second magnet part **130** is magnetized to the N pole.
(252) Accordingly, between the second magnet block **122** of the first magnet part **120** and the first magnet unit **131** of the second magnet part **130**, a magnetic field is formed in a direction from the first inner surface **131***a* toward the first and second inner surfaces **121***a* and **122***a*.
(253) Referring to FIGS. **8** and **10**, each of the inner surfaces **121***a* and **122***a* of the first magnet

part **120** and the inner surface **131***a* of the second magnet part **130** are magnetized to different polarities.
(254) That is, each of the inner surfaces **121***a* and **122***a* of the first magnet part **120** is magnetized to the N pole, and the inner surface **131***a* of the second magnet part **130** is magnetized to the S pole.
(255) Accordingly, between the second magnet block **122** of the first magnet part **120** and the first magnet unit **131** of the second magnet part **130**, a magnetic field is formed in a direction from the first and second inner surfaces **121***a* and **122***a* toward the first inner surface **131***a*.
(256) In the embodiments shown in FIG. **7**(*a*), FIG. **8**(*a*), FIG. **9**(*a*) and FIG. **10**(*a*), the direction of the electric current is the direction from the second fixed contact **22***b* through the movable contact **43** to the first fixed contact **22***a*.
(257) When Fleming's rule is applied to the first fixed contact **22***a*, the direction of the electromagnetic force generated near the first fixed contact **22***a* and the arc path A.P. may be known.
(258) That is, in the embodiments shown in FIG. **7**(*a*) and FIG. **10**(*a*), the electromagnetic force and the arc path A.P. near the first fixed contact **22***a* are formed toward the front left side.
(259) In addition, in the embodiments shown in FIG. **8**(*a*) and FIG. **9**(*a*), the electromagnetic force and the arc path A.P. near the first fixed contact **22***a* are formed toward the rear left side.
(260) Likewise, when Fleming's rule is applied to the second fixed contact **22***b*, the direction of the electromagnetic force generated near the second fixed contact **22***b* and the arc path A.P. may be known.
(261) That is, in the embodiments shown in FIG. **7**(*a*) and FIG. **10**(*a*), the electromagnetic force and the arc path A.P. near the second fixed contact **22***b* are formed toward the rear right side.
(262) In addition, in the embodiments shown in FIG. **8**(*a*) and FIG. **9**(*a*), the electromagnetic force and the arc path A.P. near the second fixed contact **22***h* are formed toward the front right side.
(263) In the embodiments shown in FIG. **7**(*h*), FIG. **8**(*b*), FIG. **9**(*b*) and FIG. **10**(*b*), the direction of the electric current is the direction from the first fixed contact **22***a* through the movable contact **43** to the second fixed contact **22***b*.
(264) When Fleming's rule is applied to the first fixed contact **22***a*, the direction of the electromagnetic force generated near the first fixed contact **22***a* and the arc path A.P. may be known.
(265) That is, in the embodiments shown in FIG. **7**(*b*) and FIG. **10**(*b*), the electromagnetic force and the arc path A.P. near the first fixed contact **22***a* are formed toward the rear left side.
(266) In addition, in the embodiments shown in FIG. **8**(*b*) and FIG. **9**(*b*), the electromagnetic force and the arc path A.P. near the first fixed contact **22***a* are formed toward the front left side.
(267) Likewise, when Fleming's rule is applied to the second fixed contact **22***b*, the direction of the electromagnetic force generated near the second fixed contact **22***b* and the arc path A.P. may be known.
(268) That is, in the embodiments shown in FIG. **7**(*b*) and FIG. **10**(*b*), the electromagnetic force and the arc path A.P. near the second fixed contact **22***b* are formed toward the front right side.
(269) In addition, in the embodiments shown in FIG. **8**(*b*) and FIG. **9**(*b*), the electromagnetic force and the arc path A.P. near the second fixed contact **22***b* are formed toward the rear right side.
(270) Therefore, the arc path forming part **100** according to the present embodiment may form the electromagnetic force and the arc path A.P in a direction away from the central portion C, regardless of the polarity of the first and second magnet parts **120** and **130** or the direction of the electric current energizing through the direct current relay **1**.
(271) Moreover, each arc path A.P formed near each of the fixed contacts **22***a* and **22***b* is formed in a direction away from each other.
(272) Accordingly, damage to each component of the direct current relay **1** disposed adjacent to the central portion C can be prevented. Furthermore, the generated arc can be quickly discharged to the

outside, so that the operation reliability of the direct current relay **1** can be improved.
(273) (2) Description of Arc Path Forming Part **200** According to Another Embodiment of the Present Disclosure
(274) Hereinafter, the arc path forming part **200** according to another embodiment of the present disclosure will be described in detail with reference to FIGS. **11** to **16**.
(275) Referring to FIGS. **11** and **12**, the arc path forming part **200** according to the illustrated embodiment includes a magnet frame **210**, a first magnet part **220** and a second magnet part **230**.
(276) The magnet frame **210** according to the present embodiment has the same structure and function as the magnet frame **110** according to the above-described embodiment. However, the first magnet part **220** and the second magnet part **230** disposed on the magnet frame **210** according to the present embodiment are different from the arc path forming part **100** according to the above-described embodiment.
(277) Therefore, the description of the magnet frame **210** will be replaced with the description of the magnet frame **110** according to the above-described embodiment.
(278) The first magnet part **220** may form a magnetic field together with other magnetic materials. In the illustrated embodiment, the first magnet part **220** may form a magnetic field together with the second magnet part **230**.
(279) The first magnet part **220** may be positioned adjacent to one of the third and fourth surfaces **213** and **214**. In an embodiment, the first magnet part **220** may be coupled to an inner side (i.e., in a direction toward the space part **215**) of any one of the surfaces.
(280) In the embodiment shown in FIG. **11**, the first magnet part **220** is disposed inside the third surface **213** and adjacent to the third surface **213**. In the embodiment shown in FIG. **12**, the first magnet part **220** may be disposed inside the fourth surface **214** and adjacent to the fourth surface **214**.
(281) The first magnet part **220** is disposed to face the second magnet part **230**. In the embodiment shown in FIG. **11**, the first magnet part **220** is disposed to face the second magnet part **230** located inside the fourth surface **214**. In the embodiment shown in FIG. **12**, the first magnet part **220** is disposed to face the second magnet part **230** located inside the third surface **213**.
(282) The space part **215** and the fixed contact **22** and the movable contact **43** accommodated in the space part **215** are positioned between the first magnet part **220** and the second magnet part **230**.
(283) The first magnet part **220** may strengthen the intensity of the magnetic field formed by itself and the magnetic field formed together with the second magnet part **230**. Since the direction of the magnetic field formed by the first magnet part **220** and the process of strengthening the magnetic field are well-known techniques, a detailed description thereof will be omitted.
(284) In the illustrated embodiment, a plurality of magnetic materials constituting the first magnet part **220** are arranged side by side from the front side to the rear side. In addition, the plurality of magnetic materials constituting the first magnet part **220** extend in the front-rear direction.
(285) That is, the plurality of magnetic materials constituting the first magnet part **20** are arranged side by side in the extension direction.
(286) In the illustrated embodiment, the first magnet part **220** includes a first magnet block **221**, a second magnet block and a third magnet block **223**. It will be understood that the plurality of magnetic materials constituting the first magnet part **220** are named magnet blocks **221**, **222** and **223**, respectively.
(287) The first to third magnet blocks **221**, **222** and **223** may be formed of a magnetic material. In an embodiment, the first to third magnet blocks **221**, **222** and **223** may be provided as permanent magnets or electromagnets or the like.
(288) The first to third magnet blocks **221**, **222** and **223** may be arranged side by side in one direction. In the illustrated embodiment, the first to third magnet blocks **221**, **222** and **223** are disposed side by side in a direction in which the third surface **213** extends, that is, in the front and rear direction.

(289) Among the first to third magnet blocks **221**, **222** and **223**, the first magnet block **221** is disposed on the rear side and the second magnet block **222** is disposed on the front side. Also, the third magnet block **223** is located between the first magnet block **221** and the second magnet block **222**.
(290) In the above embodiment, the third magnet block may overlap the fixed contact **22** along the left-right direction, that is, along the direction in which the first surface **211** or the second surface **212** extends.
(291) In the above embodiment, the first to third magnet blocks **221**, **222** and **223** may be in contact with each other. That is, the third magnet block **223** may be in contact with the first magnet block **221** and the second magnet block **222**, respectively.
(292) In the above embodiment, it will be understood that the first magnet part **220** may function as a Halbach array.
(293) The first to third magnet blocks **221**, **222** and **223** include a plurality of surfaces, respectively.
(294) Specifically, the first magnet block **221** includes a first inner surface **221***a* facing the second magnet block **222** or the third magnet block **223** and a first outer surface **221***b* opposite to the second magnet block **222** or the third magnet block **223**.
(295) The second magnet block **222** includes a second inner surface **222***a* facing the first magnet block **221** or the third magnet block **223** and a second outer surface **222***b* opposite to the first magnet block **221** or the third magnet block **223**.
(296) The third magnet block **223** includes a third inner surface **223***a* facing the space part **215** or the second magnet part **230** and a third outer surface **223***b* opposite to the space part **215** or the second magnet part **230**.
(297) The plurality of surfaces of each of the magnet blocks **221**, **222** and **223** may be magnetized according to a predetermined rule.
(298) That is, the first inner surface **221***a*, the second inner surface **222***a* and the third inner surface **223***a* are magnetized to the same polarity. In addition, the first outer surface **221***b*, the second outer surface **222***b* and the third outer surface **223***b* are each magnetized to a polarity different from the above polarity.
(299) In this case, the first inner surface **221***a*, the second inner surface **222***a* and the third inner surface **223***a* may be magnetized to the same polarity as the first outer surface **231***b* of the second magnet part **230**. That is, the first inner surface **221***a*, the second inner surface **222***a* and the third inner surface **223***a* are magnetized to a polarity different from that of the first inner surface **231***a* of the second magnet part **230**.
(300) Likewise, the first outer surface **221***b*, the second outer surface **222***h* and the third outer surface **3***b* are magnetized to the same polarity as the first inner surface **231***a* of the second magnet part **230**, That is, the first outer surface **221***b*, the second outer surface **222***b* and the third outer surface **223***b* are magnetized to a polarity different from that of the first outer surface **231***b* of the second magnet part **230**.
(301) In the embodiments shown in (a) of FIG. **11** and (a) of FIG. **12**, the first inner surface **221***a*, the second inner surface **222***a* and the third inner surface **223***a* are each magnetized to the S pole. In the above embodiment, the first inner surface **231***a* of the second magnet part **230** is magnetized to the N pole different from the above polarity.
(302) In addition, in the embodiments shown in (b) of FIG. **11** and (b) of FIG. **12**, the first inner surface **221***a*, the second inner surface **222***a* and the third inner surface **223***a* are each magnetized to the N pole. In the above embodiment, the first inner surface **231***a* of the second magnet part **230** is magnetized to the S pole different from the above polarity.
(303) The second magnet part **230** may form a magnetic field together with other magnetic materials. In the illustrated embodiment, the second magnet part **230** may form a magnetic field together with the first magnet part **220**.
(304) The second magnet part **230** may be positioned adjacent to the other one of the third and

fourth surfaces **213** and **214**. In an embodiment, the second magnet part **230** may be coupled to an inner side (i.e., in a direction toward the space part **215**) of the other one of the surfaces.
(305) In the embodiment shown in FIG. **11**, the second magnet part **230** is disposed inside the fourth surface **214** and adjacent to the fourth surface **214**. In the embodiment shown in FIG. **12**, the second magnet part **230** may be disposed inside the third surface **213** and adjacent to the third surface **213**.
(306) The second magnet part **230** is disposed to face the first magnet part **220** with the space part **215** interposed therebetween. In the embodiment shown in FIG. **11**, the second magnet part **230** is disposed to face the first magnet part **220** located inside the third surface **213**. In the embodiment shown in FIG. **12**, the second magnet part **230** is disposed to face the first magnet part **220** located inside the fourth surface **214**.
(307) The space part **215** and the fixed contact **22** and the movable contact **43** accommodated in the space part **215** are positioned between the second magnet part **230** and the first magnet part **220**.
(308) The second magnet part **230** may strengthen the intensity of the magnetic field formed by itself and the magnetic field formed together with the first magnet part **220**. Since the direction of the magnetic field formed by the second magnet part **230** and the process of strengthening the magnetic field are well-known techniques, a detailed description thereof will be omitted.
(309) In an embodiment, the second magnet part **230** may be formed to have stronger magnetism than each of the magnet blocks **221**, **222** and **223** constituting the first magnet part **220**. This is due to the fact that the number of magnet units provided in the second magnet part **230** is smaller than the number of magnet blocks provided in the first magnet part **220**.
(310) In an embodiment, the second magnet part **230** may be provided as an Nd magnet (Neodymium Magnet) or an NIB magnet (Neodymium-Iron-Boron Magnet).
(311) In the illustrated embodiment, the second magnet part **230** includes a first magnet unit **231**. It will be understood that the magnetic material constituting the second magnet part **230** is named the magnet unit **231**.
(312) The first magnet unit **231** may be formed of a magnetic material. In an embodiment, the first magnet unit **231** may be provided as a permanent magnet or an electromagnet or the like.
(313) The first magnet unit **231** may extend in a direction in which the first magnet part **220** extends, that is, in the front and rear direction in the illustrated embodiment, in an embodiment, the first magnet unit **231** may extend by a length longer than each of the magnet blocks **221**, **222** and **223**.
(314) The first magnet unit **231** may be disposed to overlap each of the fixed contacts **22***a* and **22***b* in a direction toward the third surface **213**, that is, in the left and right directions in the illustrated embodiment. In other words, the first magnet unit **231** may be disposed to overlap the fixed contact **22** along the direction in which the first surface **211** or the second surface **212** extends.
(315) The first magnet unit **231** includes a plurality of surfaces.
(316) Specifically, the first magnet unit **231** includes a first inner surface **231***a* facing the space part **215** or the first magnet part **220** and a first outer surface **231***b* opposite to the space part **215** or the first magnet part **220**.
(317) The plurality of surfaces of the first magnet unit **231** may be magnetized according to a predetermined rule.
(318) The first inner surface **231***a* and the first outer surface **231***b* are magnetized to different polarities. In this case, the first inner surface **231***a* may be magnetized to the same polarity as each of the outer surfaces **221***b*, **222***b* and **223***h* of the first magnet part **220**. In other words, the first inner surface **231***a* may be magnetized to a polarity different from that of each of the inner surfaces **221***a*, **222***a* and **223***a* of the first magnet part **220**.
(319) Likewise, the first outer surface **231***b* may be magnetized to the same polarity as each of the inner surfaces **221***a*, **222***a* and **223***a* of the first magnet part **220**. In other words, the first outer surface **231***b* may be magnetized to a polarity different from that of each of the outer surfaces **221***b*,

222*b* and **223***b* of the first magnet part **220**.
(320) In the embodiments shown in (a) of FIG. **11** and (a) of FIG. **12**, the first inner surface **231***a* is magnetized to the N pole, in the above embodiment, the first inner surface **221***a*, the second inner surface **222***a* and the third inner surface **223***a* of the first magnet part **220** are each magnetized to the S pole.
(321) In addition, in the embodiments shown in (b) of FIG. **11** and (b) of FIG. **12**, the first inner surface **231***a* is magnetized to the S pole. In the above embodiment, the first inner surface **221***a*, the second inner surface **222***a* and the third inner surface **223***a* of the first magnet part **220** are each magnetized to the N pole.
(322) Accordingly, a magnetic field directed from one of the first magnet part **220** and the second magnet part **230** toward the other magnet part is formed in the space part **215**.
(323) Hereinafter, the arc path A.P formed by the arc path forming part **200** according to the present embodiment will be described in detail with reference to FIGS. **13** to **16**.
(324) Referring to FIGS. **13** and **15**, each of the inner surfaces **221***a*, **222***a* and **223***a* of the first magnet part **220** and the inner surface **231***a* of the second magnet part **230** are magnetized to different polarities.
(325) That is, each of the inner surfaces **221***a*, **222***a* and **223***a* of the first magnet part **220** is magnetized to the S pole, and the inner surface **231***a* of the second magnet part **230** is magnetized to the N pole.
(326) Accordingly, between the second magnet block **222** of the first magnet part **220** and the first magnet unit **231** of the second magnet part **230**, a magnetic field is formed in a direction from the first inner surface **231***a* toward the first to third inner surfaces **221***a*. **222***a* and **223***a*.
(327) Referring to FIGS. **14** and **16**, each of the inner surfaces **221***a*, **222***a* and **223***a* of the first magnet part **220** and the inner surface **231***a* of the second magnet part **230** are magnetized to different polarities.
(328) That is, each of the inner surfaces **221***a*, **222***a* and **223***a* of the first magnet part **220** is magnetized to the N pole, and the inner surface **231***a* of the second magnet part **230** is magnetized to the S pole.
(329) Accordingly, between the second magnet block **222** of the first magnet part **220** and the first magnet unit **231** of the second magnet part **230**, a magnetic field is formed in a direction from the first to third inner surfaces **221***a*, **222***a* and **223***a* toward the first inner surface **231***a*.
(330) In the embodiments shown in FIG. **13**(*a*), FIG. **14**(*a*), FIG. **15**(*a*) and FIG. **16**(*a*) the direction of the electric current is the direction from the second fixed contact **22***b* through the movable contact **43** to the first fixed contact **22***a*.
(331) When Fleming's rule is applied to the first fixed contact **22***a*, the direction of the electromagnetic force generated near the first fixed contact **22***a* and the arc path A.P. may be known.
(332) That is, in the embodiments shown in FIG. **13**(*a*) and FIG. **16**(*a*), the electromagnetic force and the arc path A.P. near the first fixed contact **22***a* are formed toward the front left side.
(333) In addition, in the embodiments shown in FIG. **14**(*a*) and FIG. **15**(*a*), the electromagnetic force and the arc path A.P. near the first fixed contact **22***a* are formed toward the rear left side.
(334) Likewise, when Fleming's rule is applied to the second fixed contact **22***b*, the direction of the electromagnetic force generated near the second fixed contact **22***h* and the arc path A.P. may be known.
(335) That is, in the embodiments shown in FIG. **13**(*a*) and FIG. **16**(*a*), the electromagnetic force and the arc path A.P. near the second fixed contact **22***b* are formed toward the rear right side.
(336) In addition, in the embodiments shown in FIG. **14**(*a*) and FIG. **15**(*a*), the electromagnetic force and the arc path A.P. near the second fixed contact **22***b* are formed toward the front right side.
(337) In the embodiments shown in FIG. **13**(*b*), FIG. **14**(*b*), FIG. **15**(*b*) and FIG. **16**(*b*), the direction of the electric current is the direction from the first fixed contact **22***a* through the movable

contact **43** to the second fixed contact **22***b*.
(338) When Fleming's rule is applied to the first fixed contact **22***a*, the direction of the electromagnetic force generated near the first fixed contact **22***a* and the arc path A.P. may be known.
(339) That is, in the embodiments shown in FIG. **13**(*b*) and FIG. **16**(*b*), the electromagnetic force and the arc path A.P. near the first fixed contact **22***a* are formed toward the rear left side.
(340) In addition, in the embodiments shown in FIG. **14**(*b*) and FIG. **15**(*b*), the electromagnetic force and the arc path A.P. near the first fixed contact **22***a* are formed toward the front left side.
(341) Likewise, when Fleming's rule is applied to the second fixed contact **22***h*, the direction of the electromagnetic force generated near the second fixed contact **22***h* and the arc path A.P. may be known.
(342) That is, in the embodiments shown in FIG. **13**(*b*) and FIG. **16**(*h*), the electromagnetic force and the arc path A.P. near the second fixed contact **22***b* are formed toward the front right side.
(343) In addition, in the embodiments shown in FIG. **14**(*b*) and FIG. **15**(*b*), the electromagnetic force and the arc path A.P. near the second fixed contact **22***b* are formed toward the rear right side.
(344) Therefore, the arc path forming part **200** according to the present embodiment may form the electromagnetic force and the arc path A.P in a direction away from the central portion C, regardless of the polarity of the first and second magnet parts **220** and **230** or the direction f the electric current energizing through the direct current relay **1**.
(345) Moreover, each arc path A.P formed near each of the fixed contacts **22***a* and **22***b* is formed in a direction away from each other.
(346) Accordingly, damage to each component of the direct current relay **1** disposed adjacent to the central portion C can be prevented. Furthermore, the generated arc can be quickly discharged to the outside, so that the operation reliability of the direct current relay **1** can be improved.
(347) (3) Description of Arc Path Forming Part **300** According to Vet Another Embodiment of the Present Disclosure
(348) Hereinafter, the arc path forming part **300** according to yet another embodiment of the present disclosure will be described in detail with reference to FIGS. **17** to **22**.
(349) Referring to FIGS. **17** and **18**, the arc path forming part **300** according to the illustrated embodiment includes a magnet frame **310**, a first magnet part **320** and a second magnet part **330**.
(350) The magnet frame **310** according to the present embodiment has the same structure and function as the magnet frames **110** and **210** according to the above-described. embodiments. However, the first magnet part **320** and the second magnet part **330** disposed on the magnet frame **310** according to the present embodiment are different from the arc path forming parts **100** and **200** according to the above-described embodiments.
(351) Therefore, the description of the magnet frame **310** will be replaced with the descriptions of the magnet frames **110** and **210** according to the above-described embodiments.
(352) The first magnet part **320** may form a magnetic field together with other magnetic materials. In the illustrated embodiment, the first magnet part **320** may form a magnetic field together with the second magnet part **330**.
(353) The first magnet part **320** may be positioned adjacent to one of the third and fourth surfaces **313** and **314**. In an embodiment, the first magnet part **320** may be coupled to an inner side (i.e., in a direction toward the space part **315**) of any one of the surfaces.
(354) In the embodiment shown in FIG. **17**, the first magnet part **320** is disposed inside the third surface **313** and adjacent to the third surface **313**. In the embodiment shown in FIG. **18**, the first magnet part **320** may be disposed inside the fourth surface **314** and adjacent to the fourth surface **314**.
(355) The first magnet part **320** is disposed to face the second magnet part **330**, In the embodiment show n in FIG. **17**, the first magnet part **320** is disposed to face the second magnet part **330** located inside the fourth surface **314**. In the embodiment shown in FIG. **18**, the first magnet part **320** is

disposed to face the second magnet part **330** located inside the third surface **313**.
(356) The space part **315** and the fixed contact **22** and the movable contact **43** accommodated in the space part **315** are positioned between the first magnet part **320** and the second magnet part **330**.
(357) The first magnet part **320** may strengthen the intensity of the magnetic field formed by itself and the magnetic field formed together with the second magnet part **330**. Since the direction of the magnetic field formed by the first magnet part **320** and the process of strengthening the magnetic field are well-known techniques, a detailed description thereof will be omitted.
(358) In the illustrated embodiment, a plurality of magnetic materials constituting the first magnet part **320** are arranged side by side from the front side to the rear side. In addition, the plurality of magnetic materials constituting the first magnet part **320** extend in the front-rear direction.
(359) That is, the plurality of magnetic materials constituting the first magnet part **320** are arranged side by side in the extension direction.
(360) In the illustrated embodiment, the first magnet part **320** includes a first magnet block **321**, a second magnet block **322** and a third magnet block **323**. It will be understood that the plurality of magnetic materials constituting the first magnet part **320** are named magnet blocks **321**, **322** and **323**, respectively.
(361) The first to third magnet blocks **321**, **322** and **323** may be formed of a magnetic material. In an embodiment, the first to third magnet blocks **321**, **322** and **323** may be provided as permanent magnets or electromagnets or the like.
(362) The first to third magnet blocks **321**, **322** and **323** may be arranged side by side in one direction. In the illustrated embodiment, the first to third magnet blocks **321**, **322** and **323** are disposed side by side in a direction in which the third surface **313** extends, that is, in the front and rear direction.
(363) Among the first to third magnet blocks **321**, **322** and **323**, the first magnet block **321** is disposed on the rear side and the second magnet block **322** is disposed on the front side. Also, the third magnet block **323** is located between the first magnet block **321** and the second magnet block **322**.
(364) In the above embodiment, the third magnet block **323** may overlap the fixed contact **22** along the left-right direction, that is, along the direction in which the first surface **311** or the second surface **312** extends.
(365) In the above embodiment, the first to third magnet blocks **321**, **322** and **323** may be in contact with each other. That is, the third magnet block **323** may be in contact with the first magnet block **321** and the second magnet block **322**, respectively.
(366) In the above embodiment, it will be understood that the first magnet part **320** may function as a Halbach array.
(367) The first to third magnet blocks **321**, **322** and **323** include a plurality of surfaces, respectively.
(368) Specifically, the first magnet block **321** includes a first inner surface **321***a* facing the second magnet block **322** or the third magnet block **323** and a first outer surface **321***b* opposite to the second magnet block **322** or the third magnet block **323**.
(369) The second magnet block **322** includes a second inner surface **322***a* facing the first magnet block **321** or the third magnet block **323** and a second outer surface **322***b* opposite to the first magnet block **321** or the third magnet block **323**.
(370) The third magnet block **323** includes a third inner surface **323***a* facing the space part **315** or the second magnet part **330** and a third outer surface **323***b* opposite to the space part **315** or the second magnet part **330**.
(371) The plurality of surfaces of each of the magnet blocks **321**, **322** and **323** may be magnetized according to a predetermined rule.
(372) That is, the first inner surface **321***a*, the second inner surface **322***a* and the third inner surface **323***a* are magnetized to the same polarity. In addition, the first outer surface **321***b*, the second outer surface **322***b* and the third outer surface **323***b* are each magnetized to a polarity different from the

above polarity.
(373) In this case, the first inner surface **321***a*, the second inner surface **322***a* and the third inner surface **323***a* may be magnetized to the same polarity as the first and second outer surfaces **331***b* and **332***b* of the second magnet part **330**. That is, the first inner surface **321***a*, the second inner surface **322***a* and the third inner surface **323***a* are magnetized to a polarity different from that of the first and second inner surfaces **331***a* and **332***a* of the second magnet part **330**.
(374) Likewise, the first outer surface **321***b*, the second outer surface **322***b* and the third outer surface **323***b* are magnetized to the same polarity as the first and second inner surfaces **331***a* and **332***a* of the second magnet part **330**. That is, the first outer surface **321***b*, the second outer surface **322***b* and the third outer surface **323***b* are magnetized to a polarity different from that of the first and second outer surfaces **331***b* and **332***h* of the second magnet part **330**.
(375) In the embodiments shown in (a) of FIG. **17** and (a) of FIG. **18**, the first inner surface **321***a*, the second inner surface **322***a* and the third inner surface **323***a* are each magnetized to the S pole. In the above embodiment, the first inner surface **331***a* and the second inner surface **332***a* of the second magnet part **330** are each magnetized to the N pole different from the above polarity.
(376) In addition, in the embodiments shown in (b) of FIG. **17** and (b) of FIG. **18**, the first inner surface **321***a*, the second inner surface **322***a* and the third inner surface **323***a* are each magnetized to the N pole. In the above embodiment, the first inner surface **331***a* and the second inner surface **332***a* of the second magnet part **330** are magnetized to the S pole different from the above polarity.
(377) The second magnet part **330** may form a magnetic field together with other magnetic materials. In the illustrated embodiment, the second magnet part **330** may form a magnetic field together with the first magnet part **320**.
(378) The second magnet part **330** may be positioned adjacent to the other one of the third and fourth surfaces **313** and **314**. In an embodiment, the second magnet part **330** may be coupled to an inner side (i.e., in a direction toward the space part **315**) of the other one of the surfaces.
(379) In the embodiment shown in FIG. **17**, the second magnet part **330** is disposed inside the fourth surface **314** and adjacent to the fourth surface **314**. In the embodiment shown in FIG. **18**, the second magnet part **330** may be disposed inside the third surface **313** and adjacent to the third surface **313**.
(380) The second magnet part **330** is disposed to face the first magnet part **320** with the space part **315** interposed therebetween. In the embodiment shown in FIG. **17**, the second magnet part **330** is disposed to face the first magnet part **320** located inside the third surface **313**. In the embodiment shown in FIG. **18**, the second magnet part **330** is disposed to face the first magnet part **320** located inside the fourth surface **314**.
(381) The space part **315** and the fixed contact **22** and the movable contact **43** accommodated in the space part **315** are positioned between the second magnet part **330** and the first magnet part **320**.
(382) The second magnet part **330** may strengthen the intensity of the magnetic field formed by itself and the magnetic field formed together with the first magnet part **320**. Since the direction of the magnetic field formed by the second magnet part **330** and the process of strengthening the magnetic field are well-known techniques, a detailed description thereof will be omitted.
(383) In an embodiment, the second magnet part **330** may be formed to have stronger magnetism than each of the magnet blocks **321**, **322** and **323** constituting the first magnet part **320**. This is due to the fact that the number of magnet units provided in the second magnet part **330** is smaller than the number of magnet blocks provided in the first magnet part **320**.
(384) In an embodiment, the second magnet part **330** may be provided as an Nd magnet (Neodymium Magnet) or an NIB magnet (Neodymium-Iron-Boron Magnet).
(385) In the illustrated embodiment, the second magnet part **330** includes a first magnet unit **331** and a second magnet unit **332**. It will be understood that the magnetic material constituting the second magnet part **330** is named the magnet units **331** and **332**, respectively.
(386) The first magnet unit **331** may be formed of a magnetic material. In an embodiment, the first

magnet unit **331** may be provided as a permanent magnet or an electromagnet or the like.
(387) The first magnet unit **331** may extend in a direction in which the first magnet part **320** extends, that is, in the front and rear direction in the illustrated embodiment. In an embodiment, the first magnet unit **331** may extend by a length longer than each of the magnet blocks **321**, **322** and **323**.
(388) The first magnet unit **331** may be positioned to be biased to one of the first surface **311** and the second surface **312**. In the illustrated embodiment, the first magnet unit **331** is positioned to be biased to the first surface **311** positioned at the rear side. That is, in the above embodiment, the first magnet unit **331** is positioned to be biased to the rear side.
(389) The second magnet unit **332** is positioned adjacent to the first magnet unit **331**. In the illustrated embodiment, the first magnet unit **331** and the second magnet unit **332** are positioned to be spaced apart from each other along its extending direction, that is, in the front-rear direction.
(390) The second magnet unit **332** may be formed of a magnetic material. In an embodiment, the second magnet unit **332** may be provided as a permanent magnet or an electromagnet or the like.
(391) The second magnet unit **332** may extend in a direction in which the first magnet part **320** extends, that is, in the front-rear direction in the illustrated embodiment. In an embodiment, the second magnet unit **332** may extend by a length longer than each of the magnet blocks **321**, **322** and **323**.
(392) The second magnet unit **332** may be positioned to be biased to the other one of the first surface **311** and the second surface **312**. In the illustrated embodiment, the second magnet unit **332** is positioned to be biased to the second surface **312** positioned at the front side. That is, in the above embodiment, the second magnet unit **332** is positioned to be biased to the front side.
(393) The second magnet unit **332** is positioned adjacent to the first magnet unit **331**. In the illustrated embodiment, the second magnet unit **332** is positioned to be spaced apart from the first magnet unit **331** along its extending direction, that is, in the front-rear direction.
(394) In an embodiment not shown, the first magnet unit **331** and the second magnet unit **332** may be in contact with each other. In the above embodiment, it will be understood that the second magnet part **330** may function as a Halbach array.
(395) Each of the first magnet unit **331** and the second magnet unit **332** includes a plurality of surfaces.
(396) Specifically, the first magnet unit **331** includes a first inner surface **331***a* facing the second magnet unit **332** and a first outer surface **331***b* opposite to the second magnet unit **332**.
(397) Likewise, the second magnet unit **332** includes a second inner surface **332***a* facing the first magnet unit **331** and a second outer surface **332***b* opposite to the first magnet unit **331**.
(398) The plurality of surfaces of the first magnet unit **331** and the second magnet unit **332** may be magnetized according to a predetermined rule.
(399) The first inner surface **331***a* and the second inner surface **332***a* are magnetized to the same polarity. In addition, the first outer surface **331***b* and the second outer surface **332***h* are each magnetized to a polarity different from the above polarity.
(400) In this case, the first inner surface **331***a* and the second inner surface **332***a* are magnetized to the same polarity as each of the outer surfaces **321***h*, **322***b* and **323***h* of the first magnet part **320**. In other words, the first inner surface **332***a* and the second inner surface **332***a* may be magnetized to a polarity different from that of each of the inner surfaces **321***a*, **322***a* and **323***a* of the first magnet part **320**.
(401) Likewise, the first outer surface **331***b* and the second outer surface **332***b* are magnetized to the same polarity as each of the inner surfaces **321***a*, **322***a* and **323***a* of the first magnet part **320**. In other words, the first outer surface **331***h* and the second outer surface **332***b* may be magnetized to a polarity different from that of each of the outer surfaces **321***b*, **322***b* and **323***b* of the first magnet part **320**.
(402) In the embodiments shown in (a) of FIG. **17** and (a) of FIG. **18**, the first inner surface **331***a*

and the second inner surface **332***a* are each magnetized to the N pole. In the above embodiment, the first inner surface **321***a*, the second inner surface **322***a* and the third inner surface **323***a* of the first magnet part **320** are each magnetized to the S pole.
(403) In addition, in the embodiments shown in (b) of FIG. **17** and (b) of FIG. **18**, the first inner surface **331***a* and the second inner surface **332***a* are each magnetized to the S pole. In the above embodiment, the first inner surface **321***a*, the second inner surface **322***a* and the third inner surface **323***a* of the first magnet part **320** are each magnetized to the N pole.
(404) Accordingly, a magnetic field directed from one of the first magnet part **320** and the second magnet part **330** toward the other magnet part is formed in the space part **315**.
(405) Hereinafter, the arc path A.P formed by the arc path forming part **300** according to the present embodiment will be described in detail with reference to FIGS. **19** to **22**.
(406) Referring to FIGS. **19** and **21**, each of the inner surfaces **321***a*, **322***a* and **323***a* of the first magnet part **320** and each of the inner surfaces **331***a* and **332***a* of the second magnet part **330** are magnetized to different polarities.
(407) That is, each of the inner surfaces **321***a*, **322***a* and **323***a* of the first magnet part **320** is magnetized to the S pole, and each of the inner surfaces **331***a* and **332***a* of the second magnet part **330** is magnetized to the N pole.
(408) Accordingly, between the second magnet block **322** of the first magnet part **320** and the first magnet unit **331** of the second magnet part **330**, a magnetic field is formed in a direction from the first and second inner surfaces **331***a* and **332***a* toward the first to third inner surfaces **321***a*, **322***a* and **323***a*.
(409) Referring to FIGS. **20** and **22**, each of the inner surfaces **321***a*, **322***a* and **323***a* of the first magnet part **320** and each of the inner surfaces **331***a* and **332***a* of the second magnet part **330** are magnetized to different polarities.
(410) That is, each of the inner surfaces **321***a*, **322***a* and **323***a* of the first magnet part **320** is magnetized to the N pole, and each of the inner surfaces **331***a* and **332***a* of the second magnet part **330** is magnetized to the S pole.
(411) Accordingly, between the second magnet block **322** of the first magnet part **320** and the first magnet unit **331** of the second magnet part **330**, a magnetic field is formed in a direction from the first to third inner surfaces **321***a*, **322***a* and **323***a* toward the first and second inner surfaces **331***a* and **332***a*.
(412) In the embodiments shown in FIG. **19**(*a*), FIG. **20**(*a*), FIG. **21**(*a*) and FIG. **22**(*a*), the direction of the electric current is the direction from the second fixed contact **22***h* through the movable contact **43** to the first fixed contact **22***a*.
(413) When Fleming's rule is applied to the first fixed contact **22***a*, the direction of the electromagnetic force generated near the first fixed contact **22***a* and the arc path A.P. may be known.
(414) That is, in the embodiments shown in FIG. **19**(*a*) and FIG. a), the electromagnetic force and the arc path A.P. near the first fixed contact **22***a* are formed toward the front left side.
(415) In addition, in the embodiments shown in FIG. **20**(*a*) and FIG. **21**(*a*), the electromagnetic force and the arc path A.P. near the first fixed contact **22***a* are formed toward the rear left side.
(416) Likewise, when Fleming's rule is applied to the second fixed contact **22***b*, the direction of the electromagnetic force generated near the second fixed contact **22***b* and the arc path A.P. may be known.
(417) That is, in the embodiments shown in FIG. **19**(*a*) and FIG. **22**(*a*), the electromagnetic force and the arc path A.P, near the second fixed contact **22***b* are formed toward the rear right side.
(418) In addition, in the embodiments shown in FIG. **20**(*a*) and FIG. **21**(*a*), the electromagnetic force and the arc path A.P. near the second fixed contact **22***b* are formed toward the front right side.
(419) In the embodiments shown in FIG. **19**(*b*), FIG. **20**(*b*), FIG. **21**(*b*) and FIG. **22**(*b*), the direction of the electric current is the direction from the first fixed contact **22***a* through the movable

contact **43** to the second fixed contact **22***b*.
(420) When Fleming's rule is applied to the first fixed contact **22***a*, the direction of the electromagnetic force generated near the first fixed contact **22***a* and the arc path A.P. may be known.
(421) That is, in the embodiments shown in FIG. **19**(*b*) and FIG. **22**(*b*), the electromagnetic force and the arc path A.P. near the first fixed contact **22***a* are formed toward the rear left side.
(422) In addition, in the embodiments shown in FIG. **20**(*b*) and FIG. **21**(*b*), the electromagnetic force and the arc path A.P. near the first fixed contact **22***a* are formed toward the front left side.
(423) Likewise, when Fleming's rule is applied to the second fixed contact **22***h*, the direction of the electromagnetic force generated near the second fixed contact **22***h* and the arc path A.P. may be known.
(424) That is, in the embodiments shown in FIG. **19**(*b*) and FIG. **22**(*h*), the electromagnetic force and the arc path A.P. near the second fixed contact **22***b* are formed toward the front right side.
(425) In addition, in the embodiments shown in FIG. **20**(*b*) and FIG. **21**(*h*), the electromagnetic force and the arc path A.P near the second fixed contact **22***b* are formed toward the rear right side.
(426) Therefore, the arc path forming part **300** according to the present embodiment may form the electromagnetic force and the arc path A.P in a direction away from the central portion **3**C, regardless of the polarity of the first and second magnet parts **320** and **330** or the direction of the electric current energizing through the direct current relay **1**.
(427) Moreover, each arc path A.P formed near each of the fixed contacts **22***a* and **22***b* is formed in a direction away from each other.
(428) Accordingly, damage to each component of the direct current relay **1** disposed adjacent to the central portion **3**C can be prevented. Furthermore, the generated arc can be quickly discharged to the outside, so that the operation reliability of the direct current relay **1** can be improved.
(429) Although the above has been described with reference to preferred embodiments of the present disclosure, it will be understood that those skilled in the art can variously modify and change the present disclosure without departing from the spirit and scope of the present disclosure described in the claims below. **1**: direct current relay **10**: frame part **11**: upper frame **12**: lower frame **13**: insulating plate **14**: support plate **20**: switch part **21**: arc chamber **22**: fixed contact **22***a*: first fixed contact **22***b*: second fixed contact **23**: sealing member **30**: core part **31**: stationary core **32**: movable core **33**: yoke **34**: bobbin **35**: coil **36**: return spring **37**: cylinder **40**: movable contact part **41**: housing **42**: cover **43**: movable contact **44**: shaft **45**: elastic part **100**: arc path forming part according to an embodiment of the present disclosure **110**: magnet frame **111**: first surface **112**: second surface **113**: third surface **114**: fourth surface **115**: space part **120**: first magnet part **121**: first magnet block **121***a*: first inner surface **121***b*: first outer surface **122**: second magnet block **122***a*: second inner surface **122***b*: second outer surface **130**: second magnet part **131**: first magnet unit **131***a*: first inner surface [**54 131***b*: first outer surface **200**: arc path forming part according to another embodiment of the present disclosure **210**: magnet frame **211**: first surface **212**: second surface **213**: third surface **214**: fourth surface **215**: space part **220**: first magnet part **221**: first magnet block **221***a*: first inner surface **221***b*: first outer surface **222**: second magnet block **222***a*: second inner surface **222***b*: second outer surface **773**: third magnet block **223***a*: third inner surface **223***b*: third outer surface **230**: second magnet part **231**: first magnet unit **231***a*: first inner surface **231***b*: first outer surface **300**: arc path forming part according to yet another embodiment of the present disclosure **310**: magnet frame **311**: first surface **312**: second surface **313**: third surface **314**: fourth surface **315**: space part **320**: first magnet part **321**: first magnet block **321***a*: first inner surface **321***b*: first outer surface **322**: second magnet block **322***a*: second inner surface **322***b*: second outer surface **323**: third magnet block **323***a*: third inner surface **323***b*: third outer surface **330**: second magnet part **331**: first magnet unit **331***a*: first inner surface **331***b*: first outer surface **332**: second magnet unit **332***a*: second inner surface **332***b*: second outer surface **1000**: direct current relay according to a related art **1100**: fixed contact according to a related art **1200**: movable

contact according to a related art **1300**: permanent magnet according to a related art **1310**: first permanent magnet according to a related art **1320**: second permanent magnet according to a related art C: central portion of space part **115**, **215**, **315** A.P: arc path

Claims

1. An arc path forming part, comprising: a magnet frame comprising a space part for accommodating an arc chamber and a plurality of surfaces surrounding the space part; a first magnet part accommodated in the space part and comprising a magnet part disposed on at least one of the plurality of surfaces of the magnet frame, wherein the magnet part is positioned adjacent to one surface of the plurality of surfaces; and a second magnet part positioned adjacent to the other one surface of the plurality of surfaces facing the first magnet part with the space part interposed therebetween, wherein the first magnet part comprises a plurality of magnet blocks disposed side by side in a direction in which the one surface extends, each inner surface thereof facing each other being magnetized to the same polarity, and wherein an inner surface of the second magnet part facing the first magnet part is magnetized to a polarity different from said polarity.
2. The arc path forming part of claim 1, wherein the first magnet part comprises: a first magnet block that extends in a direction in which the one surface of the magnet frame extends, and is positioned to be biased to one side in the extending direction; and a second magnet block that extends in the same direction as the direction in which the first magnet block extends, and is positioned to be biased to the other side of the extending direction.
3. The arc path forming part of claim 2, wherein the first magnet block and the second magnet block are disposed spaced apart from each other.
4. The arc path forming part of claim 2, wherein the second magnet part extends in a direction in which the other one surface of the magnet frame extends.
5. The arc path forming part of claim 1, wherein a magnetic intensity of the second magnet part is greater than a magnetic intensity of any one of the plurality of magnet blocks of the first magnet part.
6. The arc path forming part of claim 5, wherein the second magnet part is an Nd magnet (Neodymium Magnet) or an NIB magnet (Neodymium-Iron-Boron Magnet).
7. The arc path forming part of claim 1, wherein a fixed contact and a movable contact accommodated in the arc chamber are positioned between the first magnet part and the second magnet part.
8. An arc path forming part, comprising: a magnet frame comprising a space part for accommodating a fixed contact; a first magnet part comprising a magnet part accommodated in the space part, the magnet part being biased to one side of the space part; and a second magnet part positioned biased to the other side of the space part to face the first magnet part with the space part interposed therebetween, wherein the first magnet part comprises at least a pair of magnet blocks, each having an inner surface facing each other and magnetized to the same polarity, and at least one magnet block having an inner surface facing the second magnet part and magnetized to the same polarity as said polarity, the magnet blocks of the first magnet part being disposed side by side toward another other side and yet another other side opposite thereto, and wherein an outer surface of the second magnet part opposite to the space part is magnetized to the same polarity as said polarity.
9. The arc path forming part of claim 8, wherein the first magnet part comprises: a first magnet block positioned biased to one of the another other side and the yet another other side and extending along the disposition direction; a second magnet block positioned biased to the other one of the another other side and the yet another other side and extending along the disposition direction; and a third magnet block positioned between the first magnet block and the second magnet block and extending along the disposition direction.

10. The arc path forming part of claim 9, wherein an inner surface of the first magnet block facing the third magnet block and an inner surface of the second magnet block facing the third magnet block are magnetized to the same polarity, and among surfaces of the third magnet block, an inner surface facing the second magnet part is magnetized to the same polarity as each of the inner surfaces of the first magnet block and the second magnet block.
11. The arc path forming part of claim 9, wherein the third magnet block is in contact with the first magnet block and the second magnet block, respectively, so that the first magnet part is formed in a Halbach array.
12. The arc path forming part of claim 8, wherein a magnetic intensity of the second magnet part is greater than a magnetic intensity of any one of the plurality of magnet blocks of the first magnet part.
13. The arc path forming part of claim 12, wherein the second magnet part is an Nd magnet (Neodymium Magnet) or an NIB magnet (Neodymium-Iron-Boron Magnet).
14. An arc path forming part, comprising: a magnet frame comprising a space part for accommodating a fixed contact; a first magnet part comprising a magnet part accommodated in the space part, the magnet part being biased to one side of the space part; and a second magnet part positioned biased to the other side of the space part to face the first magnet part with the space part interposed therebetween, wherein the first magnet part comprises at least a pair of magnet blocks, each having an inner surface facing each other and magnetized to the same polarity, and at least one magnet block having an inner surface facing the second magnet part and magnetized to the same polarity as said polarity, the magnet blocks of the first magnet part being disposed side by side toward another other side and yet another other side opposite thereto, and wherein the second magnet part comprises: a first magnet unit positioned biased to one of the another other side and the yet another other side and extending along the disposition direction; and a second magnet unit posited biased to the other one of the another other side and the yet another other side and extending along the disposition direction.
15. The arc path forming part of claim 14, wherein an inner surface of surfaces of the first magnet unit facing the space part and an inner surface of surfaces of the second magnet unit facing the space part are magnetized to the same polarity.
16. The arc path forming part of claim 15, wherein each of the inner surfaces of the plurality of magnet blocks of the first magnet part is magnetized to a polarity different from that of each of the inner surfaces of the first magnet unit and the second magnet unit of the second magnet part.
17. A direct current relay, comprising: a fixed contact electrically connected to an external power source and load; a movable contact coming into contact with and spaced apart from the fixed contact; an arc chamber for accommodating the fixed contact and the movable contact; and an arc path forming part that surrounds the arc chamber and directs an arc generated inside the arc chamber, wherein the movable contact has a length in one direction longer than a length in the other direction, wherein the arc path forming part comprises: a first magnet part disposed spaced apart from the movable contact along the one direction on one side of the movable contact; and a second magnet part disposed on the other side of the movable contact and spaced apart from the movable contact along the one direction to face the first magnet part with the movable contact interposed therebetween, wherein the first magnet part comprises a plurality of magnet blocks disposed side by side along the other direction and having inner surfaces facing each other magnetized to the same polarity, and wherein an inner surface of the second magnet part facing the first magnet part is magnetized to a polarity different from said polarity.
18. A direct current relay, comprising: a fixed contact electrically connected to an external power source and load; a movable contact coming into contact with and spaced apart from the fixed contact; and an arc path forming part in which a space part for accommodating the fixed contact and the movable contact is formed therein, wherein the arc path forming part comprises: a pair of surfaces partially surrounding the space part and disposed to face each other; a first magnet part

disposed adjacent to one of the pair of surfaces in the space part; and a second magnet part disposed adjacent to the other one of the pair of surfaces in the space part, wherein the first magnet part comprises at least a pair of magnet blocks, each having an inner surface facing each other and magnetized to the same polarity, and at least one magnet block having an inner surface facing the second magnet part and magnetized to the same polarity as said polarity, the magnet blocks of the first magnet part being disposed side by side toward another other side and yet another other side opposite thereto, and wherein an inner surface of the second magnet part facing the first magnet part is magnetized to a polarity different from said polarity.

19. A direct current relay, comprising: a fixed contact electrically connected to an external power source and load; a movable contact coming into contact with and spaced apart from the fixed contact; and an arc path forming part in which a space part for accommodating the fixed contact and the movable contact is formed therein, wherein the arc path forming part comprises: a pair of surfaces surrounding a portion of the space part and disposed to face each other; another pair of surfaces surrounding the remaining portion of the space part, being continuous with the pair of surfaces, and disposed to face each other; a first magnet part disposed adjacent to one of the pair of surfaces in the space part; and a second magnet part disposed adjacent to the other one of the pair of surfaces in the space part, wherein the first magnet part comprises at least a pair of magnet blocks, each having an inner surface facing each other and magnetized to the same polarity, and at least one magnet block having an inner surface facing the second magnet part and magnetized to the same polarity as said polarity, the magnet blocks of the first magnet part being disposed side by side toward another other side and yet another other side opposite thereto, and wherein the second magnet part comprises a plurality of magnet units disposed side by side along a direction in which the other surface extends, each inner surface facing each other being magnetized to a polarity different from said polarity.