

Description

ELECTROMAGNET DEVICE

Technical Field

[0001] The present invention relates to an electromagnet device, and more particularly, it is preferably applied to a switch in which an excitation coil and a permanent magnet are provided.

Background Art

[0002] In a switch such as a breaker, a pair of electrodes are provided inside thereof, a movable side rod is drawn from one electrode to the outside, and a drawn movable side rod is connected to a movable shaft to which an armature is attached.

Thus when an exciting current is energized to an excitation coil of an electromagnet device, an armature is driven to a stator side by magnetic attractive force of the generated magnetic flux.

Then this driving force is transmitted through a movable shaft to the movable side rod, and a switch is shifted to a closing state by making one electrode contact with another electrode. There are a constant excitation, a mechanical latch, and an electromagnetic latch as means to keep this closing state.

[0003] A constant excitation is used to keep a closing state by continuing to energize an excitation coil at all time after a switch is shifted to a closing state and consequently it causes increasing of an electric power consumption.

A mechanical latch is used to keep a closing state by latching mechanically with a suitable construction and generally needs a complicated form, and consequently needs maintenance to control

consumption of a driving portion such as application of lubricating oil.

On the other hand, an electromagnetic latch is used to keep a closing state with an electromagnetic attractive force of a permanent magnet as described in JP Laid-Open 2002-8498 and allows to save power consumption by stopping to energize to an excitation coil, or by decreasing of energizing current when a switch is shifted to a closing state.

[0004] However, in an electromagnetic latch even if power supply is powered off at the time of blackout or the like, a closing state with an electromagnetic attractive force of a permanent magnet, that is, even if power supply is powered off, a closing state is kept. Therefore there is a problem that it will be unfitted to the field which needs to be broken by a breaker when power supply is powered off.

On the other hand, since a constant excitation keeps a closing state by continuing to energize an excitation coil at all time, it allows a breaker to break automatically if power supply is powered off at a time of blackout or the like.

However, a constant excitation causes an increasing of power consumption in order to keep a closing state and consequently it is unfitted to the field which needs to keep a closing state when power supply is powered off.

Therefore an object of the present invention is to provide an electromagnetic device capable of simply changing between a electromagnetic latch and a constant excitation without being accompanied with complexity of constitution.

Disclosure of the Invention

[0005] In order to solve the above problems, with the electromagnetic device according to the present invention,

an electromagnetic device comprising:

[an armature which is attached to a movable shaft;]

a movable shaft with an armature attached;

[a stator into which the movable shaft is inserted] a stator which is inserted by the movable shaft and which is contactable and releasable with the armature;

an excitation coil which is placed to surround the armature and the stator and generate magnetic force to shift the armature in a direction of the stator;

a permanent magnet which generate magnetic force to hold a contact state with the stator;

a frame which surrounds the excitation coil and the permanent magnet and forms magnetic passage to shift the armature in a direction of the stator by magnetic flux of the excitation coil and the permanent magnet; and

a magnetic short-circuiting plate which is provided [removably] so as to span the permanent magnet and makes a magnetic flux content occurred from the permanent magnet decreased,

wherein a magnetic flux reduced by the magnetic short-circuiting plate when the armature and the stator contact with each other is complemented with a magnetic flux from the excitation coil.

[0006] Further with the electromagnetic device according to the embodiment of the present invention, further comprising:

a first magnetic plate which is placed so as to contact with an inner surface of the frame and one pole of the permanent magnet [so as not to contact with the armature], and

a second magnetic plate which is placed slidably with the armature [so as not to contact the frame] and is placed so as to contact with other pole of the permanent magnet,

wherein the magnetic short-circuiting plate is [bridged] placed removably between the first magnetic plate and the second magnetic plate.

[0007] Further with the electromagnetic device according to the embodiment of the present invention, further comprising:

[the permanent magnet and the excitation coil are placed side by side along the movable shaft and the permanent magnet is supported in the frame in such a manner to be sandwiched between the first magnetic plate and the second magnetic plate.]

a first magnetic plate which is placed so as to contact with an inner surface of the frame without contacting with the armature and so as to contact with one pole of the permanent magnet, and

a second magnetic plate which is placed slidably with the armature so as not to contact with the frame and is placed so as to contact with other pole of the permanent magnet,

wherein the magnetic short board is bridged between the first magnetic plate and the second magnetic plate.

Further with the electromagnetic device according to the embodiment of the present invention,

wherein [a magnetic flux content occurred from the permanent magnet is increased or decreased by making a cross section area of the magnetic short-circuiting plate increase or decrease.]

the permanent magnet and the excitation coil are arranged side by side along the movable shaft, and

the permanent magnetic is supported in the frame in such a manner to be sandwiched between the first magnetic plate and the

second magnetic plate.

Further with the electromagnetic device according to the embodiment of the present invention,

wherein [the first magnetic body and the second magnetic body are made with their contact surfaces with the magnetic short-circuiting plate formed in R shape.]

the magnetic flux occurred from the permanent magnet is increased or decreased by making a cross section area of the magnetic short-circuiting plate increasing or decreasing.

Further with the electromagnetic device according to the embodiment of the present invention,

wherein the first magnetic plate and the second magnetic plate are made with their contact surfaces with the magnetic short-circuiting plate formed in R shape.

Brief description of Drawings

[0008] FIG. 1 is a sectional view showing a release state of an electromagnet device of the embodiment according to the present invention.

FIG. 2 is a sectional view showing a closing state of an electromagnet device of the embodiment according to the present invention.

FIG. 3 is a front view showing a constitution of an electromagnet device as viewed from the direction of A2 in FIGS. 1 and 2.

FIG. 4 is a side view showing a constitution of an electromagnet device as viewed from the direction of A3 in FIG. 3.

Explanation of the Numerals

[0009] 1 movable shaft, 1a movable screw, 1b movable nut, 2 armature, 2a gap, 2b stator, 3a support ditch, 4a spring ditch, 5 clearance portion, 6 frame, 6a frame edge, 7 end plate, 8 excitation coil, 8a coil frame, 9 permanent magnet, 10a magnetic passage, 11 and 12 magnetic plate, 13 space portion, 14 clamping bolt, 15 clamping nut, 16 magnetic short-circuiting plate

Best Mode for Carrying Out the Invention

[0010] Hereinafter, referring to the drawings, an electromagnetic device of the embodiment according to the present invention is described.

FIG. 1 is a sectional view showing a release state of an electromagnet device of the embodiment according to the present invention, cut off along A1-A1 in FIG.3. FIG. 2 is a sectional view showing a closing state of an electromagnet device of the embodiment according to the present invention. FIG. 3 is a front view showing a constitution of an electromagnet device as viewed from the direction of A2 in FIGS.1 and 2. FIG. 4 is a side view showing a constitution of an electromagnet device as viewed from the direction of A3 in FIG. 3.

[0011] In FIGS. 1-4, an electromagnet device is provided with an armature 2 and a stator 3 which are contactable and releasable each other, and is provided with a breaking spring 4 which is biased to make the armature 2 and the stator 3 spaced.

In addition, the electromagnet device is provided with an excitation coil 8 to make the armature 2 contacted with the stator 3, and is provided with a permanent magnet 9 to generate the magnet power to maintain a contact state of the armature 2 and the stator

3.

The armature 2 and the stator 3 are formed cylindrically, and the armature 2 is fixed to a movable shaft 1 which goes through a center of the electromagnet device while the movable shaft 1 is inserted into the stator 3 via a through hole formed inside thereof.

The armature 2 and the stator 3 are arranged so as to form clearance portion 5 which can make armature 2 apart from stator 3 at the time of release.

Here, a movable screw 1a is formed at one end of the movable shaft 1, and a movable nut 1b is attached to the movable screw 1a so that the armature 2 can be fixed to the movable shaft 1 by tightening the movable nut 1b.

[0012] In addition, a spring ditch 4a is formed along the movable shaft 1 at the side of opposite surface of the armature 2 and the stator 3.

And a breaking spring 4 is placed so as to span the clearance portion 5.

Further a tube-like frame 6 is provided which surrounds the armature 2 and the stator 3 at outside of the armature 2 and the stator 3.

Here, at one end of the frame 6, a frame end 6a is formed which crosses directly with the movable shaft 1, while at other end of the frame 6, an end plate 7 is attached which is placed in opposition to the frame end 6a.

[0013] In the frame end 6a, a through-hole is formed into which stator 3 is inserted and in the stator 3 a support ditch 3a is formed into which the tip of the frame end 6a is inserted.

Thus the stator 3 and the frame 6 are fixed by inserting the tip of the frame end 6a into the support ditch 3a.

In addition, in an outer peripheral sides of the armature 2 and the stator 3, an excitation coil 8 and a permanent magnet 9 are placed which are enclosed in the frame 6.

Here, the excitation coil 8 and the permanent magnet 9 may be placed side by side along the movable shaft 1.

[0014] The excitation coil 8 may be constituted cylindrically so that parts of the armature 2 and the stator 3 are surrounded.

Thus the excitation coil 8 is formed by winding electric wire to a coil frame 8a having a hollow portion so that the armature 2 and the stator 3 may be inserted into the hollow portion of the excitation coil 8.

Here, a gap 2a may be formed along the movable shaft 1 between the armature 2 and the coil frame 8a.

In addition the permanent magnet 9 may be constituted, for example, in the shape of ring-like so that a part of the armature 2 is surrounded.

On the other hand the permanent magnet 9 may be constituted in the shape other than ring-like, for example, in the shape of bar so as to be placed above and below with the armature 2.

[0015] In addition the permanent magnet 9 is sandwiched between the magnetic plates 11 and 12 and fixed to the frame 6 with the magnetic plates 11 and 12.

Here, the magnetic plate 11 is placed so as to contact with inner surface of the frame 6 without contacting with the armature 2 and so as to contact with one pole of the coil frame 8a and the permanent magnet 9.

Further a space portion 13 which communicates to the gap 2a is formed by the magnetic plate 11 and the permanent magnet 9.

In addition the magnetic plate 12 is placed slidably with the

armature 2 without contacting with the frame 6, and is placed so as to contact with other pole of the permanent magnet 9.

[0016] In addition a clamping bolt 14 is placed between the magnetic plate 12 and the end plate 7 and the clamping bolt 14 is inserted into the through hole formed in the end plate 7.

Thus a clamping nut 15 is mounted to the screw ditch of the clamping bolt 14 and the clamping nut 15 is clamped so that the clamping bolt 14 are pressed on the magnetic plate 12, thereby allowing the excitation coil 8 and the permanent magnet 9 to be supported between the clamping bolt 14 and the frame end 6a.

[0017] In addition a magnetic short-circuiting plate 16 is provided removably between the magnetic plates 11 and 12 so as to span the permanent magnet 9.

Here the magnetic short-circuiting plate 16 may be bridged between magnetic plates 11 and 12 so as to sort magnetically between magnetic plates 11 and 12 and this allows a magnetic flux content occurred from the permanent magnet 9 to be decreased.

On the other hand the magnetic short-circuiting plate 16 may be formed with a steal plate or the like so that the magnetic short-circuiting plate 16 could be mounted and removed between magnetic plates 11 and 12 by magnetic attractive force from the permanent magnet 9.

In addition a magnetic flux content may be increased or decreased by making the cross section area of the magnetic short-circuiting plate 16 increase or decrease.

On the other hand in the end portion 11a and 11b of respective magnetic plates 11 and 12, R surface 17 may be formed at a contact surface with the magnetic short-circuiting plate 16.

[0018] Hereinafter, operations of the electromagnetic device in

FIGS.1-4 are described.

This electromagnetic device may operate as a constant excitation when the magnetic short-circuiting plate 16 is mounted and may operate as an electromagnetic latch when the magnetic short-circuiting plate 16 removed.

In addition in FIG.1 when the electromagnetic device is at the time of release, the armature 2 and the stator 3 are spaced away by the breaking spring 4 and thus a clearance portion 5 is formed between the armature 2 and the stator 3 so that the end portion of the armature 2 is kept in the state of abutting to the end plate 7.

[0019] Here when the end portion of the armature 2 abuts to the end plate 7, the magnetic flux ϕ_2 occurred in the permanent magnet 9 mainly circulates through permanent magnet 9, magnetic plate 12, armature 2, end plate 7, frame 6, magnetic plate 11, and permanent magnet 9 in order so as to form a magnetic passage 10b.

Thus in release of the electromagnetic device a magnetic attractive force from this magnetic passage 10b allows the armature 2 to keep the contact state with the end plate 7 at all time.

For this reason, the armature 2 can equalize a travel distance moving from a breaking position to a closing position and it is possible to equalize a contact time when the armature 2 can contact with the stator 3, and thus a quality of the electromagnet device can be improved.

[0020] In this state, when the excitation coil 8 is energized, and the excitation coil 8 is excited, magnetic flux ϕ_1 occurred in the excitation coil 8 mainly circulates through permanent magnet 9, magnetic plate 12, armature 2, stator 3, frame 6, magnetic plate 11, and permanent magnet 9 in order so as to form a magnetic passage

10a, and to make the magnet flux from the permanent magnet 9 flow together to the magnetic passage 10a.

In addition, the armature 2 is attracted to the stator 3 by magnetic attractive force of magnetic flux ϕ_1 and ϕ_2 flowing through the magnetic flux passage 10a, and thus, as shown in FIG.2, while the armature 2 moves in a direction to the stator 3, the armature 2 compresses the breaking spring 4, consequently the armature 2 contacts with the stator 3 so as to become a closing state.

[0021] Here, when the magnetic short-circuiting plate 16 is mounted between the magnetic plates 11 and 12, magnetic flux ϕ_2 of the permanent magnet 9 flows to the magnetic short-circuiting plate 16 so as to short between the magnetic plates 11 and 12 magnetically.

For this reason a magnetic flux content from the permanent magnet 9 decreases by a magnetic loss of magnetic short-circuiting plate 16, and magnetic attractive force of the permanent magnet 9 decreases.

For this reason a closing state is maintained by complementing for decrease of this magnetic attractive force with magnetic attractive force of magnetic flux ϕ_1 from the excitation coil 8, and thus it can be operated as a constant excitation.

[0022] On the other hand, when the magnetic short-circuiting plate 16 is removed, the armature 2 contacts with the stator 3 by magnetic attractive force from the permanent magnet 9 in the magnetic flux passage 10a so as to maintain a closing state, and thus it can be operated as an electromagnetic latch.

For this reason it can be realized to save energy of electric power, by stopping energizing to excitation coil 8, or decreasing energizing current, after a closing state is shifted to.

[0023] In this way, it can be operated as an electromagnetic latch by removing magnetic short-circuiting plate 16 so that a closing state can be kept without energizing to excitation coil 8.

Therefore it can be realized to save energy of electric power, and it is possible to keep a closing state by electromagnetic attractive force of the permanent magnet 9 even when a power supply is powered off at the time of blackouts or the like.

In addition, it can be operated as a constant excitation by mounting the magnetic short-circuiting plate 16 between the magnetic plate 11 and 12 so that a breaking state can be automatically shifted to, when a power supply is powered off at the time of blackouts or the like.

[0024] For this reason it is possible to use one electromagnet device as both an electromagnetic latch and a constant excitation, and it is possible to be easily switched an electromagnetic latch and a constant excitation without being accompanied with complexity of constitution.

Therefore it can depress upsizing and high price of an electromagnet device, while improve convenience of an electromagnet device.

In addition, in the electromagnet device of the present invention, it can be switched from a constant excitation to an electromagnetic latch only by removing the magnet short-circuiting plate 16, therefore, even if it is an existing electromagnet device, it can be easily shifted from a constant excitation to an electromagnetic latch.

[0025] In the above described embodiment a method is described to make the armature 2 spaced from the stator 3 by the release power of accumulation energy of the breaking spring 4, however, the

breaking spring 4 is not always needed because the armature 2 can be spaced from stator 3 by only reverse magnetic attractive force of the excitation coil 8.

In addition, the magnetic short-circuiting plate 16 arranged between magnetic plates 11 and 12 can be observed from the outside of the electromagnet device so that a production error or an imitation by a third person can be discovered easily.

[0026] In addition, a magnetic flux content occurred from the permanent magnet 9 can make increase and decrease by making a cross section area of the magnetic short-circuiting plate 16 increase and decrease so that an exciting current energized to excitation coil 8 can be adjusted to an arbitrary value.

In addition, in respective magnetic plate 11 and 12, magnetic flux can be centralized in R surface 17 by forming R surface at a contact surface with magnetic short-circuiting plate 16.

Therefore leakage magnetic flux can be decreased as much as forming of the R surface 17 and thus it can make a magnetic loss reduced and make magnetic efficiency improved.

Industrial Applicability

[0027] The present invention can be utilized, for example, in electromagnetic actuators used in a switch or a breaking device, such as a circuit breaker or a leakage breaker, and it can be applied to whichever of the field where it is necessary to break a breaker at the time of blackout or the field where it is necessary to keep a closing state at the time of blackout.

CLAIMS

1. An electromagnetic device comprising:

[an armature which is attached to a movable shaft;]

a movable shaft with an armature attached;

[a stator into which the movable shaft is inserted] a stator which is inserted by the movable shaft and which is contactable and releasable with the armature;

an excitation coil which is placed to surround the armature and the stator and generate magnetic force to shift the armature in a direction of the stator;

a permanent magnet which generate magnetic force to hold a contact state with the stator;

a frame which surrounds the excitation coil and the permanent magnet and forms magnetic passage to shift the armature in a direction of the stator by magnetic flux of the excitation coil and the permanent magnet; and

a magnetic short-circuiting plate which is provided [removably] so as to span the permanent magnet and makes a magnetic flux content occurred from the permanent magnet decreased,

wherein a magnetic flux reduced by the magnetic short-circuiting plate when the armature and the stator contact with each other is complemented with a magnetic flux from the excitation coil.

2. The electromagnetic device according to claim 1, further comprising,

a first magnetic plate which is placed so as to contact with an inner surface of the frame and one pole of the permanent magnet

[so as not to contact with the armature], and

a second magnetic plate which is placed slidably with the armature [so as not to contact the frame] and is placed so as to contact with other pole of the permanent magnet,

wherein the magnetic short-circuiting plate is [bridged] placed removably between the first magnetic plate and the second magnetic plate.

3. The electromagnetic device according to claim 1, [wherein] further comprising,
[the permanent magnet and the excitation coil are placed side by side along the movable shaft and the permanent magnet is supported in the frame in such a manner to be sandwiched between the first magnetic plate and the second magnetic plate.]

a first magnetic plate which is placed so as to contact with an inner surface of the frame without contacting with the armature and so as to contact with one pole of the permanent magnet, and

a second magnetic plate which is placed slidably with the armature so as not to contact with the frame and is placed so as to contact with other pole of the permanent magnet,

wherein the magnetic short board is bridged between the first magnetic plate and the second magnetic plate.

4. The electromagnetic device according to any one of [claims 1 to 3] claim 2 or 3, wherein

[a magnetic flux content occurred from the permanent magnet is increased or decreased by making a cross section area of the magnetic short-circuiting plate increase or decrease.]

the permanent magnet and the excitation coil are arranged side

by side along the movable shaft, and

the permanent magnetic is supported in the frame in such a manner to be sandwiched between the first magnetic plate and the second magnetic plate.

5. The electromagnetic device according to any one of claims 1 to 4, wherein

[the first magnetic body and the second magnetic body are made with their contact surfaces with the magnetic short-circuiting plate formed in R shape.]

the magnetic flux occurred from the permanent magnet is increased or decreased by making a cross section area of the magnetic short-circuiting plate increasing or decreasing.

6. The electromagnetic device according to any one of claims 1 to 5,

wherein the first magnetic plate and the second magnetic plate are made with their contact surfaces with the magnetic short-circuiting plate formed in R shape.