

Description

ELECTROMAGNETIC DEVICE

Technical Field

[0001]

The present invention relates to an electromagnetic 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 circuit breaker, a pair of electrodes is provided inside thereof, a movable side rod is drawn from one electrode to the outside, and the 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 electromagnetic device, an armature is driven to a stator side by a magnetic attractive force of the generated magnetic flux. Then this driving force is transmitted via the movable shaft to the movable side rod, and a switch is shifted to a closing state by making one electrode contacted with the other electrode. There are a constant excitation, a mechanical latch, and an electromagnetic latch as means to keep this closing state.

[0003]

The constant excitation is used to keep a closing state by continuing to energize the excitation coil at all time

after a switch is shifted to a closing state and consequently it causes an increase of a power consumption. The mechanical latch is used to keep a closing state by latching mechanically with a suitable construction and generally requires a complicated form, and consequently requires maintenance, such as an application of lubricating oil, to prevent a driving portion from wearing.

On the other hand, the electromagnetic latch is used to keep a closing state with an electromagnetic attractive force of a permanent magnet as described in JP 2002-8498 A. When the switch is shifted to a closing state, an energization to the excitation coil is stopped or energizing current is decreased, thereby allowing to save power consumption.

[0004]

However, there is a problem that if a permanent magnet having a larger electromagnetic attractive force is used, with higher performance of the permanent magnet, an electromagnetic attractive force of the permanent magnet is larger than the releasing force of isolation spring, thereby making it unable to break with the circuit breaker.

On the other hand, there is a problem that even in a case the permanent magnet having an larger electromagnetic attractive force is used, if an isolation spring having a large spring pressure is used in order to reliably break with the circuit breaker, the size of the permanent magnet will become larger.

Therefore, an object of the present invention is to provide an electromagnetic device capable of decreasing the electric power consumption to hold the closing state, with

reliably breaking with the circuit breaker while suppressing an increase of the size of the electromagnetic device.

Disclosure of the Invention

[0005]

In order to solve the above problems, the electromagnetic device according to an aspect of the present invention is characterized in that,

an electromagnetic device comprising:

an armature which is attached to a movable axis;

a stator into which the movable axis is inserted and which is contact or detached with the armature;

an excitation coil which is located so as to surround the armature and the stator;

an isolation spring which is compressed by moving of the armature in the direction of the stator;

a permanent magnet which generates a magnetic force to maintain a contact states of the armature and the stator;

a frame which surrounds the excitation coil and the permanent magnet and forms a first magnetic flux path that allows the armature to move in the direction of the stator by a magnetic flux from the excitation coil and the permanent magnet; and

a magnetic flux content regulating section which regulates the magnetic flux content of a second magnetic flux path transmitting the magnetic flux content generated from the permanent magnet so that a magnetic attractive force generated from the permanent magnet is less than a releasing force of the isolation spring.

[0006]

Further, the electromagnetic device according to an aspect of the present invention is characterized in that,

the electromagnetic device comprising:

a back plate which is located in abuttable to the frame and fixed to the armature; and

a clamp which is located in abuttable to the back plate and sandwiches the permanent magnet with the frame,

wherein the second magnetic flux path is formed by the frame abutted to the frame, the back plate, and the clamp, and

the magnetic flux content regulating means is constituted so that a part on the second magnetic flux path is magnetically saturated more easily than the other part thereof.

[0007]

Further, the electromagnetic device according to an aspect of the present invention is characterized in that,

the electromagnetic device comprising:

a back plate which is located in abuttable to the frame and fixed to the armature;

a clamp which is located in abuttable to the back plate and sandwiches the permanent magnet with the frame; and

a regulating plate which is provided between the frame and the clamp and is located in abuttable to the back plate,

wherein the second magnetic flux path is formed by the back plate abutted to the frame, the regulating plate, and the clamp, and

the magnetic flux content regulating means is constituted so that a part of the regulating plate is magnetically

saturated more easily than the other part thereof.

Further, the electromagnetic device according to an aspect of the present invention is characterized in that,

the permanent magnet is located at the outside of the excitation coil.

Brief description of Drawings

[0008]

FIG. 1 is a sectional view showing a closing state and a releasing state of the electromagnetic device at the upper side and the lower side respectively with making a center line C0 as a border line.

FIG. 2 is a front view showing a schematic configuration of the electromagnetic device as viewed from the right side in FIG. 1.

FIG. 3 is a side view showing a closing state of the electromagnetic device of FIG. 1.

FIG. 4 is a side view showing a releasing state of the electromagnetic device of FIG. 1.

Best Mode for Carrying Out the Invention

[0009]

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 closing state and a releasing state of the electromagnetic device at the upper side and the lower side respectively with making a center line C0 as a border line. FIG. 2 is a front view showing a

schematic configuration of the electromagnetic device as viewed from the right side in FIG. 1. FIG. 3 is a side view showing a closing state of the electromagnetic device of FIG. 1. FIG. 4 is a side view showing a releasing state of the electromagnetic device of FIG. 1.

[0010]

In FIGS. 1-4, an electromagnetic device is provided with an armature 2 and a stator 3 which are contactable and detachable each other, and is provided with an isolation spring 4 which is biased to isolate the armature 2 and the stator 3. In addition, the electromagnetic 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 23 to generate a magnetic force to maintain a contact state of the armature 2 and the stator 3.

[0011]

The armature 2 and the stator 3 are formed cylindrically. The armature 2 is fixed to a movable shaft 1 which goes through a center of the electromagnetic device and the movable shaft 1 is connected via a wipe spring 29 to an operating rod 30 of a circuit breaker. In addition, the movable shaft 1 is inserted to the stator 3 via through hole formed inside the stator 3 and a slide bearing 7 is provided on the inner surface of the stator 3 contacting with the movable shaft 1.

A tubular frame 4 surrounding the armature 2 and the stator 3 is provided at outside of the armature 2 and the stator 3. A through hole in which the stator 3 is inserted is formed at a frame end 4a. In addition, the frame 4 is fixed to an attachment plate 5 by an attaching screw 6 with the bottom

surface of the back plate 4 contacted therewith.

[0012]

At outer circumference surfaces of the armature 2 and the stator 3, the flange sections 9 protruded to the outer circumference sides of the armature 2 and the stator 3 are formed respectively. An isolation spring 8 is located at the outer circumference surfaces of the armature 2 and the stator 3 and the isolation spring 8 is supported between the flange sections 9 formed at the armature 2 and the stator 3 respectively. As shown in the lower side of FIG. 1, the armature 2 and the stator 3 are arranged so that a space section 10 may be formed which allows the armature 2 to leave from the stator 3 at the time of releasing. At the outer circumference sides of the armature 2 and the stator 3, an excitation coil 12 housed in the frame 4 is located.

[0013]

Furthermore, a supporting tube 13 is located between the excitation coil 12 and the armature 2. The supporting tube 13 is inserted into the armature 2 so as to form a clearance 14 between the supporting Tube 13 and the armature 2. A back plate 15 is inserted into the movable shaft 1 located so as to contact with the armature 2. Thus the back plate 15 is tightened up by a nut 16 so that the back plate 15 is supported by the movable shaft 1. Further, a frame surface plate 17 is provided at the outside of the back plate 15 and an outside frame 19 is located on the outer circumference section of the frame surface plate 17. The outside frame 19 and the frame 4 are fixed integrally by the screw 21. The movable shaft 1 passes through the through hole of the frame

surface plate 17 to extend to the outside and a stopper 18 is attached which blocks the shift of the movable shaft 1 by abutting the back plate 15 at the time of releasing. On the other hand, the frame surface plate 17 and the outside frame 19 may be formed integrally.

[0014]

In addition, as shown in FIG. 2, the permanent magnet 23 may be located at the two cites of the outside of the excitation coil 12 at the corner of the frame 4 so as to contiguous to the back plate 15 and may be fixed between the frame 4 and an abutment plate 22. The abutment plate 22 is located parallel to the movable shaft 1, is constituted to be abutable on the back plate 15, and is supported by the supporting clamp 24. The supporting clamp 24 is extended in the right angle direction to the movable shaft 1 from the end of the supporting tube 13, is formed by being folded in the middle way to extend in the same direction with the axial direction of the movable shaft 1, and is located to surround a part of the excitation coil 12. The abutment plate 22 is located to abut the supporting clamp 24 and screwed by three fixation screws 25 between the frame 4 and the supporting clamp 24 from the through holes formed on the outside frame 19, whereby the permanent magnet 23 is supported between the frame 4 and the supporting clamp 24. The abutment plate 22 may be excluded by providing the clamp abutable to the back plate 15 at the supporting clamp 24.

[0015]

As shown in FIGS. 3 and 4, at the inside of the outside frame 19, a regulating plate 26, which regulates a magnetic

flux content in the magnetic flux path that transmits a magnetic flux generated from the permanent magnet 23, is located in abuttable on the back plate 15 to be parallel to the movable shaft 1 and is fixed to the abutment plate 22 by being tightened by the three fixation screws 25. A regulating plate section 26a at the back plate 15 side of the regulating plate 26 is constituted so that a width part or a surface area is less than that of the regulating plate section 26a of the isolation spring 8 side. The regulating plate section 26a at the back plate 15 side of the regulating plate 26 may be formed so as to be thinner than the thickness of a regulating plate section 26b of the isolation spring 8 side.

[0016]

The magnetic flux ϕ_2 generated from the permanent magnet 23 circulates in the order of the permanent magnet 23, the abutment plate 22, the back plate 15, the regulating plate 26, the frame 24, the outside frame 19, and the permanent magnet 23 to form a second magnetic flux path 27b and to act the magnetic attraction force to the back plate 15, thereby maintaining the contact state of the armature 2 and the stator 3. Thus it is possible to maintain the closing state even in a case of breaking the energization of the excitation coil 12.

[0017]

Further, it is possible to occur easily the magnetic loss by narrowing the width of the regulating plate section 26a of the back plate 15 side of the regulating plate 26 than that of the regulating plate section 26b of the isolation spring 8 side to make the regulating plate section 26a of the back plate 15 side of the regulating plate 26 tended easily to be

saturated magnetically.

Besides the method of providing the regulating plate 26, the second magnetic flux path 27b may be constituted so that the magnetic flux content of the permanent magnet 23 may be less than the releasing force of the isolation spring 8.

[0018]

Hereinafter the operations of the magnetic devices shown in FIGS. 1 to 4 are described.

As shown in the lower side of FIG. 1, at the time of releasing of the magnetic device, the armature 2 is located in opposite to the stator 3 via the space section 10. In this state when the excitation coil 12 is energized and the excitation coil 12 is excited, the magnetic flux ϕ_1 generated in the excitation coil 12 is, as indicated by the solid line, circulates mainly in the order of the frame 4, the outside frame 19, the permanent magnet 23, the back plate 15, the supporting clamp 24, the armature 2, the stator 3, and the frame 4 to form a first magnetic flux path 27a and the magnetic flux ϕ_2 of the permanent magnet 23 that transmits through the second magnetic flux path 27b also meets the first magnetic flux path 27a.

[0019]

Then the armature 2 is attracted to the stator 3 by the magnetic attractive force of the magnetic fluxes ϕ_1 and ϕ_2 flowing the magnetic flux paths 27a and 27b respectively. Then as shown in the upper side of FIG. 1 and FIG. 3, the armature 2 compresses the isolation spring 8 while moving in the direction of the stator 3 and the armature 2 contacts with the stator 3 and the closing state is shifted to. In addition,

with a movement of the armature 2, the back plate 15 abuts the abutment plate 22 and the regulating plate 26. As shown in the upper side of FIG. 1, the second magnetic flux path 27b circulating in the order of the permanent magnet 23, the abutment plate 22, the back plate 15, the regulating plate 26, the frame 4, the outside frame 19, and the permanent magnet 23 is formed. Then when the magnetic device becomes closing state, the movement of the armature 2 is blocked by being engaged by the engaging section provided on a part of the operating rod 30 of the circuit breaker not shown to maintain the compressing energy of the isolation spring 8.

[0020]

In addition, the armature 2 contacts to the stator 3 by the magnetic attraction force from the permanent magnet 23 in the second magnetic flux path 27b to maintain the closing state. Thus it is possible to realize the power consumption by stopping the energizing of the excitation coil 12 or decreasing the energizing current.

Then when the engagement of the engaging section by a breaking command from the central control center not shown, the compressing energy of the isolation spring 8 is released, and as shown in the lower side of FIG. 1 and FIG. 4 the releasing state is shifted to by releasing of the armature 2 from the stator 3.

[0021]

The regulating plate section 26a of the back plate 15 side of the regulating plate 26 is formed so that the width thereof is less than that of the regulating plate section 26b of the isolation spring 8 side. Thus when the magnetic flux ϕ_2

flows to the regulating plate 26 of the second magnetic flux path 27b, the magnetic flux content is regulated so as to be magnetically saturated by the regulating plate section 26b. This regulation can be set so that the magnetic flux content of the permanent magnet 23 becomes to be less than the releasing force of the isolation spring 8. Consequently, even in a case that the performance of the permanent magnet 23 is improved, it is possible to reliably isolate the armature 2 from the stator 3 in breaking without increasing the size of the isolation spring 8. Thus it is possible to decrease the power consumption to maintain the closing state while suppressing the increase of the size of the electromagnetic device.

[0022]

As shown in the lower side of FIG. 1 and FIG. 4, a clearance may be formed between the back plate 15 and the regulating plate 26 at the time of releasing, consequently, it is possible to make the movement of the armature 2 faster at the time of closing as much as providing this clearance, thereby making the closing time faster.

Further, it is possible to easily work the regulating section by using a thinner plate than the abutment plate 22 as the regulating plate 26. It is also possible to exclude the abutment plate 22 if the regulating plate 26 is used instead of the abutment plate 22. Further, for example, the magnetic loss that regulates the size of the clearance between one side of the regulating plate 26 or the abutment 22 and the back plate 15, may also be included in a part saturated magnetically.

Industrial Applicability

[0023]

The electromagnetic device according to the present invention can be utilized, for example, in a switch such as a circuit breaker, a leakage breaker, or an electromagnetic actuators. Thus it is possible to reliably break with the circuit breaker while suppressing the increase of the size of the electromagnetic device, and to decrease the power consumption to maintain the closing state.

CLAIMS

1. An electromagnetic device comprising:

an armature which is attached to a movable shaft;

a stator into which the movable shaft is inserted and which is contact with or detached from the armature;

an exciting coil which is located so as to surround the armature and the stator;

an opening spring which is compressed by moving the armature in the direction toward the stator;

a permanent magnet which generates a magnetic force to maintain a contact state of the armature and the stator;

a frame which surrounds the exciting coil and the permanent magnet and forms a first magnetic flux path that allows the armature to move in the direction toward the stator by a magnetic flux from the exciting coil and the permanent magnet;

a magnetic flux regulating section which regulates the magnetic flux of a second magnetic flux path permeating the magnetic flux generated from the permanent magnet so that a magnetic attractive force generated from the permanent magnet is less than a releasing force of the opening spring,

a back plate which is located in an abutable manner to the frame and fixed to the armature; and

a clamp which is located in an abutable manner to the back plate and sandwiches the permanent magnet with the frame.

wherein the second magnetic flux path is formed by the frame, the back plate abutted to the frame, the back plate and the clamp; and

the magnetic flux regulating means is constituted so that a part on the second magnetic flux path is magnetically saturated more easily than the other part thereof.

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

a regulating plate which is provided between the frame and the clamp and is located in an abutable manner to the back plate,

wherein the second magnetic flux path is formed by the back plate abutted to the frame, the regulating plate, and the clamp, and

the magnetic flux regulating plate means is constituted so that a part of the regulating plate is magnetically saturated more easily than the other part thereof.

3. The electromagnetic device according to claim 1 or claim 2 wherein the permanent magnet is located at the outside of the exciting coil.