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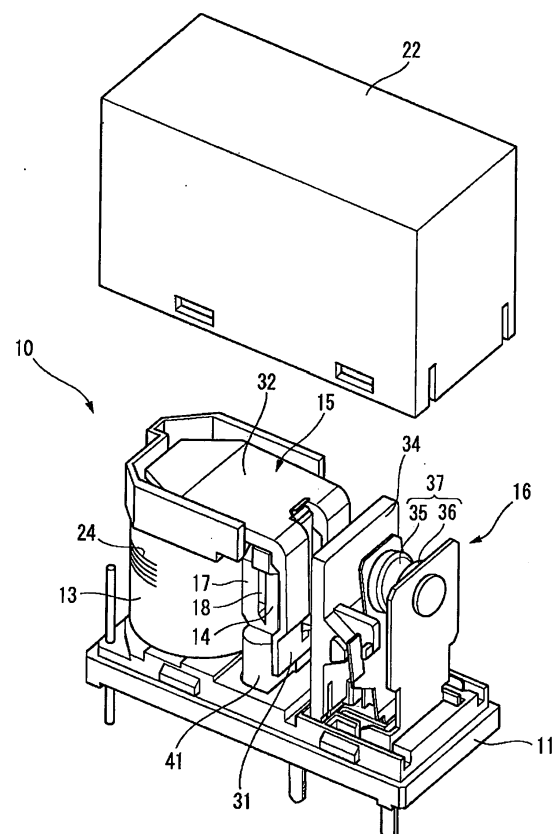
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BA ME(30) Priority: **25.11.2009 JP 2009267988**(71) Applicant: **Panasonic Electric Works Co., Ltd.****Kadoma-shi****Osaka (JP)**

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(57) An electromagnetic relay 10 includes an auxiliary yoke 17 extending along an upstanding portion 27 of a primary yoke 14 and magnetically connected to the upstanding portion 27 through a magnetic connection portion 41, a permanent magnet 18 arranged between the upstanding portion 27 of the primary yoke 14 and the auxiliary yoke 17 and a magnetic saturation portion 21 provided in the upstanding portion 27. The electromagnetic relay 10 is designed to allow the magnetic flux of the permanent magnet 18 to flow through the upstanding portion 27, an operation piece 15, the magnetic connection portion 41 and the auxiliary yoke 17 when a second attracted portion 32 is spaced apart from one end portion of an iron core 12 with the conductive coil 24 kept not excited, and to flow through the upstanding portion 27, the operation piece 15, the iron core 12, a base end portion 26, the magnetic connection portion 41 and the auxiliary yoke 17 when the second attracted portion 32 is attracted to the end portion of the iron core 12 with the conductive coil 24 kept not excited.

FIG. 1

Description

Field of the Invention

[0001] The present invention relates to an electromagnetic relay including an iron core, a bobbin arranged around the iron core, a conductive coil wound on the bobbin, an operation piece and a contact point mechanism. Upon supplying an electric current through the conductive coil, the operation piece is attracted to an end portion of the iron core. Along with such movement of the operation piece, the contact points of the contact point mechanism are connected to each other in a current-flowing state.

Background of the Invention

[0002] A conventional relay includes a plate-shaped base, an iron core provided on the base, a bobbin arranged around the iron core, a conductive coil wound on the bobbin, a yoke connected to one end portion of the iron core and an operation piece swingably supported on the yoke. As the operation piece is swung, the contact points of a contact point mechanism can make contact with or move away from each other.

[0003] With this electromagnetic relay, the operation piece is attracted to the end portion of the iron core when an electric current flows through the conductive coil wound on the bobbin. Along with such movement of the operation piece, the contact points of the contact point mechanism are connected to each other in a current-flowing state (see, e.g., Japanese Patent Application Publication No. 2009-009710 (JP2009-009710A)).

[0004] In the electromagnetic relay disclosed in JP2009-009710A, there is a need to continuously excite the conductive coil in order to keep the contact points of the contact point mechanism connected to each other.

[0005] Due to such structural features, the electromagnetic relay disclosed in JP2009-009710A has a difficulty in reducing power consumption. Thus, a demand has existed for improvement of the electromagnetic relay.

Summary of the Invention

[0006] In view of the above, the present invention provides an electromagnetic relay capable of reducing power consumption.

[0007] In accordance with an aspect of the present invention, there is provided an electromagnetic relay including: an iron core; a bobbin arranged around the iron core and wound with a conductive coil; a primary yoke including a base end portion connected to one end portion of the iron core and extending in the radial direction of the bobbin and an upstanding portion connected to the base end portion and arranged parallel to the iron core; an operation piece including a first attracted portion extending along the upstanding portion and a second attracted portion movable toward or away from the other

end portion of the iron core, the first attracted portion and the second attracted portion being connected to each other in a substantially L-like shape, the operation piece being arranged to swing about a tip end of the upstanding portion; a contact point mechanism driven by the operation of the operation piece; an auxiliary yoke extending along the upstanding portion of the primary yoke and magnetically connected to the upstanding portion through a magnetic connection portion; a permanent magnet arranged between the upstanding portion of the primary yoke and the auxiliary yoke; and a magnetic saturation portion provided between a portion of the upstanding portion or the auxiliary yoke, which is arranged near the first attracted portion of the operation piece, corresponding to the permanent magnet, and the magnetic connection portion, wherein the electromagnetic relay is designed to allow the magnetic flux of the permanent magnet to flow through the upstanding portion, the operation piece, the magnetic connection portion and the auxiliary yoke when the second attracted portion is spaced apart from the other end portion of the iron core with the conductive coil kept not excited, and to flow through the upstanding portion, the operation piece, the iron core, the base end portion, the magnetic connection portion and the auxiliary yoke when the second attracted portion is attracted to the other end portion of the iron core with the conductive coil kept not excited.

[0008] In this regard, the auxiliary yoke may be arranged at the side of the upstanding portion close to or distant from the conductive coil. The auxiliary yoke may be magnetically connected to the upstanding portion. For example, it is possible to employ a structure in which the auxiliary yoke is arranged in close contact with the upstanding portion, with a minimized clearance left therebetween. A separate member may be interposed between the auxiliary yoke and the upstanding portion as long as a desired magnetic flux can flow therethrough. Accordingly, the auxiliary yoke may be either integrally formed with or separate from the upstanding portion.

[0009] Examples of the magnetic saturation portion include a through-hole, a recess portion or a slit formed to reduce the cross-sectional area of a specified section of the upstanding portion or the auxiliary yoke and a non-magnetic member or an insulating member provided in the upstanding portion or the auxiliary yoke.

[0010] With such configuration, even if the conductive coil is not excited, the permanent magnet arranged between the upstanding portion and the auxiliary yoke can keep the second attracted portion either spaced apart from or attracted to the other end portion of the iron core.

[0011] In other words, the electric power is consumed only in the time period from the operation starting time of the operation piece to the operation ending time thereof. Therefore, it is possible to reduce power consumption as compared with the conventional electromagnetic relays.

[0012] In addition, since the electromagnetic relay of the present invention is capable of reducing the required

electric power as compared with the conventional electromagnetic relays, it is possible to employ a coil of small size and to reduce the overall size of the electromagnetic relay.

[0013] The auxiliary yoke may be arranged at the same side of the upstanding portion as the conductive coil and the magnetic saturation portion may be provided in the upstanding portion.

[0014] With such configuration, the first attracted portion can be enlarged as compared with the case where the auxiliary yoke is arranged at the opposite side of the upstanding portion from the conductive coil. This makes it possible to simplify the structure of the operation piece.

[0015] The primary yoke and the auxiliary yoke may be formed into a single piece.

[0016] With such configuration, there is no need to separately manufacture the auxiliary yoke. This helps prevent the fabrication process from becoming complicated while reducing the number of parts.

[0017] The magnetic saturation portion may be formed by reducing the cross-sectional area of a specified section of the upstanding portion.

[0018] In the present invention, the magnetic saturation portion includes, e.g., a through-hole, a recess portion or a slit. Therefore, it is possible to obtain the magnetic saturation portion in a simple and reliable manner as compared with the case where a non-magnetic member or an insulating member is provided as the magnetic saturation portion.

[0019] The magnetic saturation portion may include a through-hole formed in the upstanding portion.

[0020] With such configuration, a desired magnetic saturation degree can be obtained by appropriately selecting the position, shape and dimension of the through-hole.

[0021] At least one of opposite surfaces of the upstanding portion and the auxiliary yoke may include a step portion for holding the permanent magnet in position.

[0022] In this regard, examples of the step portion include a recess portion or a raised portion with which the end surfaces of the permanent magnet can engage. There is no need for the step portion to engage with all the end surfaces of the permanent magnet. The step portion may be arranged in any arbitrary position if it can hold the permanent magnet in position.

[0023] With such configuration, the permanent magnet is kept in position by the step portion. This reduces the possibility that the permanent magnet is moved out of its position by vibration or other causes, which makes it possible to maintain the initial performance of the permanent magnet for a prolonged period of time.

[0024] The step portion may include a recess portion formed in one of the upstanding portion and the auxiliary yoke, or a raised portion formed in one of the upstanding portion and the auxiliary yoke.

[0025] The electromagnetic relay of the present invention provides an advantageous effect in that the power consumption when the attracted portion is attracted to

the other end portion of the iron core can be reduced by arranging the permanent magnet between the upstanding portion and the auxiliary yoke.

[0026] In addition, the electromagnetic relay of the present invention is capable of reducing the required electric power as compared with the conventional electromagnetic relays. This provides an advantageous effect in that it is possible to employ a coil of small size and to reduce the overall size of the electromagnetic relay.

Brief Description of the Drawings

[0027]

Fig. 1 is a perspective view showing an electromagnetic relay according to a first embodiment of the present invention, with a cover removed from the relay.

Fig. 2 is an enlarged perspective view of the electromagnetic relay shown in Fig. 1.

Fig. 3 is a side view of the electromagnetic relay shown in Fig. 2.

Fig. 4 is a perspective view of the electromagnetic relay shown in Fig. 1, with a base removed from the relay.

Fig. 5 is a perspective view showing a primary yoke and an auxiliary yoke according to the first embodiment of the present invention.

Fig. 6 is a perspective view of the primary yoke and the auxiliary yoke shown in Fig. 5, with an upstanding portion removed from the yokes.

Fig. 7 is a perspective view illustrating one exemplary method for producing the primary yoke and the auxiliary yoke shown in Fig. 5.

Figs. 8A to 8C are side views illustrating an example in which the contact points provided in the electromagnetic relay according to the first embodiment are converted from a current-interrupting state to a current-flowing state.

Figs. 9A to 9C are side views illustrating an example in which the contact points provided in the electromagnetic relay according to the first embodiment are converted from the current-flowing state to the current-interrupting state.

Fig. 10 is a perspective view showing a primary yoke and an auxiliary yoke according to a second embodiment of the present invention.

Fig. 11 is a perspective view showing an upstanding portion according to a third embodiment of the present invention.

Fig. 12 is a perspective view showing an upstanding portion according to a fourth embodiment of the present invention.

Fig. 13 is a perspective view showing an upstanding portion according to a fifth embodiment of the present invention.

Fig. 14 is a perspective view showing an auxiliary yoke according to a sixth embodiment of the present

invention.

Figs. 15A and 15B are a perspective view and a cross sectional view showing an auxiliary yoke according to a seventh embodiment of the present invention.

Fig. 16 is a side view showing a primary yoke and an auxiliary yoke according to an eighth embodiment of the present invention.

Detailed Description of the Embodiments

[0028] An electromagnetic relay 10 according to embodiments of the present invention will now be described with reference to the accompanying drawings.

(First Embodiment)

[0029] As shown in Figs. 1 to 3, the electromagnetic relay 10 according to the first embodiment of the present invention includes a base 11, an iron core 12 erected from the base 11, a bobbin 13 provided around the iron core 12, a primary yoke 14 provided in a spaced-apart relationship with the bobbin 13, an operation piece 15 supported by the primary yoke 14, a contact point mechanism 16 supported by the operation piece 15, an auxiliary yoke 17 arranged in an opposing relationship with the primary yoke 14, a permanent magnet 18 provided between the auxiliary yoke 17 and the primary yoke 14, a magnetic saturation portion 21 provided in the primary yoke 14 and a cover 22 arranged on the base 11 for accommodating the iron core 12, the bobbin 13, the primary yoke 14, the operation piece 15, the contact point mechanism 16, the auxiliary yoke 17, the permanent magnet 18 and the magnetic saturation portion 21.

[0030] As shown in Figs. 3 to 5, the iron core 12 is fixed at one end to the base 11 and extends rectilinearly from the base 11. That is to say, the iron core 12 is raised upright from the base 11.

[0031] The bobbin 13 is made of an insulating material and is coaxially provided with respect to the iron core 12 so that it can cover the iron core 12. A conductive coil 24 is wound on the bobbin 13.

[0032] The primary yoke 14 includes a base end portion 26 connected to one end portion 12a of the iron core 12 and extending in the radial direction of the bobbin 13 and an upstanding portion 27 connected to the base end portion 26 and arranged parallel to the iron core 12. The primary yoke 14 having the base end portion 26 and the upstanding portion 27 has a substantially L-like shape when seen in a side view.

[0033] The operation piece 15 includes a first attracted portion 31 extending along the upstanding portion 27 and a second attracted portion 32 moving toward or away from the other end portion 12b of the iron core 12. The first attracted portion 31 and the second attracted portion 32 are connected to each other to form a substantially L-like shape. The operation piece 15 is a member swinging about a tip end 27a of the upstanding portion 27.

[0034] The contact point mechanism 16 includes a

card portion 34, a movable terminal 35 connected to the operation piece 15 through the card portion 34 and a fixed terminal 36 opposing to the movable terminal 35. Responsive to the operation of the operation piece 15, the card portion 34 of the contact point mechanism 16 is swung about the pivot shaft 34a. The movable terminal 35 moves together with the card portion 34. The movable terminal 35 is kept either in a contact state or a non-contact state with respect to the fixed terminal 36.

[0035] When the fixed terminal 36 and the movable terminal 35 are in the contact state, the contact point 37 (composed of the fixed terminal 36 and the movable terminal 35) comes into a current-flowing state. If the fixed terminal 36 and the movable terminal 35 are in the non-contact state, the contact point 37 comes into a current-interrupting state.

[0036] As shown in Figs. 3, 5 and 6, the auxiliary yoke 17 is arranged at the same side of the upstanding portion 27 as the conductive coil 24 while extending along the upstanding portion 27 (see Fig. 3). The auxiliary yoke 17 is magnetically connected to the upstanding portion 27 through a magnetic connection portion 41. That is to say, the upstanding portion 27 (the primary yoke 14) and the auxiliary yoke 17 are integrally formed with each other through the magnetic connection portion 41. Thus, there is no need to separately manufacture the auxiliary yoke 17. This helps prevent the fabrication process from becoming complicated while reducing the number of parts.

[0037] A step portion 42 having a substantially U-like shape (see Fig. 7) is formed on a surface 17a of the auxiliary yoke 17 opposing to the upstanding portion 27 of the primary yoke 14, thereby defining a recess portion 43 (see Fig. 7) for accommodating the permanent magnet 18. The auxiliary yoke 17 includes a bent portion 44 provided below the recess portion 43 and near the magnetic connection portion 41. The bent portion 44 is bent to extend away from the upstanding portion 27.

[0038] Due to the formation of the bent portion 44 in the auxiliary yoke 17, an accommodation space 45 (see Fig. 3) for accommodating the permanent magnet 18 is defined by the recess portion 43 and the primary yoke 14 in the state where the auxiliary yoke 17 is opposed to the primary yoke 14. The accommodation space 45 has an upper opening 46 (Fig. 3) through which the permanent magnet 18 can be inserted into the accommodation space 45. The opening 46 is not necessarily required in the present invention but may be omitted by appropriately changing the structure or fabrication process of the electromagnetic relay 10.

[0039] By arranging the permanent magnet 18 within the recess portion 43 of the auxiliary yoke 17, it is possible to keep the permanent magnet 18 in a specified position in the step portion 42. This reduces the possibility that the permanent magnet 18 is moved out of its position by vibration or other causes, which makes it possible to maintain the initial performance of the permanent magnet 18 for a prolonged period of time.

[0040] Since the positional deviation of the permanent

magnet 18 can be prevented by forming the recess portion 43 in the auxiliary yoke 17 to obtain the step portion 42, it is possible to suppress deviation of the attraction force (magnetic force) from a target value and to obtain stable operation characteristics.

[0041] The method for forming the auxiliary yoke 17, the primary yoke 14 and the magnetic connection portion 41 will be described later in respect of Fig. 7.

[0042] The permanent magnet 18 is formed into a substantially rectangular shape and inserted into the accommodation space 45 through the opening 46 shown in Fig. 3. Thus, the permanent magnet 18 is arranged between the upstanding portion 27 and the auxiliary yoke 17.

[0043] As shown in Figs. 3 and 5, the magnetic saturation portion 21 is provided between a portion 47 of the upstanding portion 27 corresponding to the permanent magnet 18 and the magnetic connection portion 41 at the side of the upstanding portion 27 connected to the first attracted portion 31.

[0044] The magnetic saturation portion 21 is a substantially rectangular opening formed in the upstanding portion 27. The magnetic saturation portion 21 is provided to reduce the cross-sectional area in a specified section of the upstanding portion 27, thereby keeping the magnetic flux flowing through the upstanding portion 27 in a saturated state.

[0045] By forming the magnetic saturation portion 21 in the form of a through-hole, it is possible to obtain the magnetic saturation portion 21 in a simple and reliable manner as compared with the case where a non-magnetic member or an insulating member is provided as the magnetic saturation portion.

[0046] In addition, by forming the magnetic saturation portion 21 in the form of the through-hole, a desired magnetic saturation degree can be obtained by appropriately selecting the position, shape and dimension of the through-hole.

[0047] In the electromagnetic relay 10, the auxiliary yoke 17 is arranged at the same side of the upstanding portion 27 as the conductive coil 24, and the magnetic saturation portion 21 is provided in the upstanding portion 27. Therefore, the first attracted portion 31 can be enlarged in proportion to the step distance of the bent portion 44 from the upstanding portion 27 as compared with the case where the auxiliary yoke 17 is arranged at the opposite side of the upstanding portion 27 from the conductive coil 24. Use of this configuration in the electromagnetic relay 10 makes it possible to simplify the structure of the operation piece 15.

[0048] As shown in Fig. 1, the cover 22 is arranged on the base 11 and formed into a substantially rectangular parallelepiped shape (box-like shape) so that it can accommodate the iron core 12, the bobbin 13, the primary yoke 14, the operation piece 15, the contact point mechanism 16, the auxiliary yoke 17, the permanent magnet 18 and the magnetic saturation portion 21.

[0049] Next, one example of the method for forming the auxiliary yoke 17, the primary yoke 14 and the mag-

netic connection portion 41 will be described in detail with reference to Fig. 7.

[0050] As shown in Fig. 7, a planar material (metal plate) is first punched into a specified shape, thereby forming the auxiliary yoke 17, the primary yoke 14 and the magnetic connection portion 41. Then, the step portion 42 is press-formed into a substantially U-like shape on the surface 17a of the auxiliary yoke 17 opposing to the upstanding portion 27 of the primary yoke 14, thus forming the recess portion 43 for accommodation of the permanent magnet 18. The recess portion 43 may be formed simultaneously with punching the planar material (metal plate) into a specified shape.

[0051] Subsequently, a through-hole as the magnetic saturation portion 21 is formed in the upstanding portion 27, after which the bent portion 44 is formed in the auxiliary yoke 17. As a result, the accommodation space 45 (see Fig. 3) for accommodating the permanent magnet 18 can be defined between the recess portion 43 and the primary yoke 14 by bringing the auxiliary yoke 17 into an opposing relationship with the primary yoke 14.

[0052] Thereafter, the base end portion 26 of the primary yoke 14 is bent toward the upstanding portion 27 at a right angle so that the primary yoke 14 having the base end portion 26 and the upstanding portion 27 can have a substantially L-like shape when seen in a side view. Then, the permanent magnet 18 is inserted into the accommodation space 45 through the opening 46 (see Fig. 3) so that it can be held within the recess portion 43 in the accommodation space 45.

[0053] Next, one example of the method for keeping the second attracted portion 32 attracted to the other end portion 12b of the iron core 12 (namely, the method for switching the contact point 37 from a current-interrupting state to a current-flowing state) will be described with reference to Figs. 8A to 8C.

[0054] As shown in Fig. 8A, the operation piece 15 is arranged in such a state that the second attracted portion 32 thereof is spaced apart from the other end portion 12b of the iron core 12. The first attracted portion 31 of the operation piece 15 is in contact with the upstanding portion 27.

[0055] In this state, the magnetic flux 50 of the permanent magnet 18 flows through the upstanding portion 27 of the primary yoke 14, the operation piece 15, the magnetic connection portion 41 and the auxiliary yoke 17. Consequently, the second attracted portion 32 of the operation piece 15 is kept spaced apart from the other end portion 12b of the iron core 12 under the influence of the magnetic flux 50 of the permanent magnet 18.

[0056] When the conductive coil 24 is kept excited as illustrated in Fig. 8B, the second attracted portion 32 of the operation piece 15 is attracted to the other end portion 12b of the iron core 12 as indicated by arrows C. The first attracted portion 31 of the operation piece 15 is moved away from the upstanding portion 27 as indicated by arrows D.

[0057] The conductive coil 24 is kept non-excited as

illustrated in Fig. 8C. In this state, the magnetic flux 50 of the permanent magnet 18 flows through the upstanding portion 27 of the primary yoke 14, the operation piece 15, the iron core 12, the base end portion 26 of the primary yoke 14, the magnetic connection portion 41 and the auxiliary yoke 17. Consequently, the second attracted portion 32 of the operation piece 15 is kept attracted to the other end portion 12b of the iron core 12 under the influence of the magnetic flux 50 of the permanent magnet 18. The second attracted portion 32 is attracted to the other end portion 12b, so that the contact point 37 (namely, the fixed terminal 36 and the movable terminal 35) shown in Fig. 3 is kept in a current-flowing state.

[0058] Next, one example of the method for keeping the second attracted portion 32 of the operation piece 15 spaced apart from the other end portion 12b of the iron core 12 (namely, the method for switching the contact point 37 from a current-flowing state to a current-interrupting state) will be described with reference to Figs. 9A to 9C.

[0059] As shown in Fig. 9A, the operation piece 15 is arranged in such a state that the second attracted portion 32 thereof is attracted to the other end portion 12b of the iron core 12. The first attracted portion 31 of the operation piece 15 is separated away from the upstanding portion 27.

[0060] In this state, the magnetic flux 50 of the permanent magnet 18 flows through the upstanding portion 27 of the primary yoke 14, the operation piece 15, the iron core 12, the base end portion 26 of the primary yoke 14, the magnetic connection portion 41 and the auxiliary yoke 17. Consequently, the second attracted portion 32 of the operation piece 15 is kept attracted to the other end portion 12b of the iron core 12 under the influence of the magnetic flux 50 of the permanent magnet 18.

[0061] When the conductive coil 24 is kept excited as illustrated in Fig. 9B, the second attracted portion 32 of the operation piece 15 is moved away from the other end portion 12b of the iron core 12 as indicated by arrows E. The first attracted portion 31 of the operation piece 15 is moved toward the upstanding portion 27 as indicated by arrows F, thereby making contact with the upstanding portion 27.

[0062] The conductive coil 24 is kept non-excited as illustrated in Fig. 9C. In this state, the magnetic flux 50 of the permanent magnet 18 flows through the upstanding portion 27 of the primary yoke 14, the operation piece 15, the magnetic connection portion 41 and the auxiliary yoke 17. Consequently, the first attracted portion 31 of the operation piece 15 is kept in contact with the upstanding portion 27 (namely, the second attracted portion 32 of the operation piece 15 is kept spaced apart from the other end portion 12b of the iron core 12) under the influence of the magnetic flux 50 of the permanent magnet 18. The second attracted portion 32 is spaced apart from the other end portion 12b, so that the contact point 37 (namely, the fixed terminal 36 and the movable terminal 35) shown in Fig. 3 is kept in a current-interrupting state.

[0063] As described above in connection with Figs. 8A through 8C and Figs. 9A through 9C, the permanent magnet 18 arranged between the upstanding portion 27 and the auxiliary yoke 17 is capable of keeping the second attracted portion 32 spaced apart from the other end portion 12b of the iron core 12 even if the conductive coil 24 is not excited. Likewise, the permanent magnet 18 is capable of keeping the second attracted portion 32 attracted to the other end portion 12b of the iron core 12 even when the conductive coil 24 is not excited.

[0064] With the electromagnetic relay 10 set forth above, the conductive coil 24 is excited (namely, the electric power is consumed) only in the time period from the operation starting time of the operation piece 15 to the operation ending time thereof. Therefore, as compared with the conventional electromagnetic relays, it is possible to reduce power consumption when the second attracted portion 32 is kept spaced apart from the other end portion 12b of the iron core 12 or when the second attracted portion 32 is kept attracted to the other end portion 12b of the iron core 12.

[0065] In addition, since the electromagnetic relay 10 is capable of reducing the required electric power as compared with the conventional electromagnetic relays, it is possible to employ a coil of small size and to reduce the overall size of the electromagnetic relay 10.

[0066] Next, second to eight embodiments will be described with reference to Figs. 10 through 16. In the following description, the components identical with or similar to those of the electromagnetic relay 10 of the first embodiment will be designated by like reference numerals and will be omitted from description.

(Second Embodiment)

[0067] Referring to Fig. 10, the primary yoke 14 and the auxiliary yoke 17 according to the second embodiment are formed from separate members. Other configurations remain the same as the first embodiment.

[0068] By forming the primary yoke 14 and the auxiliary yoke 17 from separate members, it becomes possible to make the primary yoke 14 and the auxiliary yoke 17 differ in thickness. This makes it possible to control the magnetic force to have a desired value.

(Third Embodiment)

[0069] Referring to Fig. 11, the upstanding portion 60 of the third embodiment differs from the upstanding portion 27 of the first embodiment in that the magnetic saturation portion 21 provided in the upstanding portion 27 of the first embodiment is changed to a magnetic saturation portion 61. Other configurations remain the same as the first embodiment.

[0070] The magnetic saturation portion 61 of the present embodiment is a recess portion formed on the surface 62 of the upstanding portion 27 opposing to the operation piece 15 shown in Fig. 3.

[0071] By forming the recess portion as the magnetic saturation portion 61 in the upstanding portion 60, it is possible to reduce the cross-sectional area in a specified section of the upstanding portion 60 and to obtain the magnetic saturation portion 61 in a simple and reliable manner as compared with the case where a non-magnetic member or an insulating member is provided as the magnetic saturation portion.

[0072] In addition, by forming the magnetic saturation portion 61 in the form of the recess portion, a desired magnetic saturation degree can be obtained by appropriately selecting the position, shape and dimension of the recess portion.

(Fourth Embodiment)

[0073] Referring to Fig. 12, the upstanding portion 70 of the fourth embodiment differs from the upstanding portion 27 of the first embodiment in that the magnetic saturation portion 21 provided in the upstanding portion 27 of the first embodiment is changed to a magnetic saturation portion 71. Other configurations remain the same as the first embodiment.

[0074] The magnetic saturation portion 71 of the present embodiment includes a plurality of circular through-holes formed in the upstanding portion 70.

[0075] By forming the through-holes as the magnetic saturation portion 71 in the upstanding portion 70, it is possible to reduce the cross-sectional area in a specified section of the upstanding portion 70 and to obtain the magnetic saturation portion 71 in a simple and reliable manner as compared with the case where a non-magnetic member or an insulating member is provided as the magnetic saturation portion.

[0076] In addition, by forming the magnetic saturation portion 71 in the form of the through-holes, a desired magnetic saturation degree can be obtained by appropriately selecting the position, shape and dimension of the through-holes.

(Fifth Embodiment)

[0077] Referring to Fig. 13, the upstanding portion 80 of the fifth embodiment differs from the upstanding portion 27 of the first embodiment in that the magnetic saturation portion 21 provided in the upstanding portion 27 of the first embodiment is changed to a magnetic saturation portion 81. Other configurations remain the same as the first embodiment.

[0078] The magnetic saturation portion 81 of the present embodiment includes a plurality of circular blind holes formed on the surface 82 of the upstanding portion 80 opposing to the operation piece 15 shown in Fig. 3.

[0079] By forming the blind holes as the magnetic saturation portion 81 in the upstanding portion 80, it is possible to reduce the cross-sectional area in a specified section of the upstanding portion 80 and to obtain the magnetic saturation portion 81 in a simple and reliable

manner as compared with the case where a non-magnetic member or an insulating member is provided as the magnetic saturation portion.

[0080] In addition, if the magnetic saturation portion 81 is formed in the form of blind holes, a desired magnetic saturation degree can be obtained by appropriately selecting the position, shape and dimension of the blind holes.

10 (Sixth Embodiment)

[0081] Referring to Fig. 14, the auxiliary yoke 90 of the sixth embodiment differs from the auxiliary yoke 17 of the first embodiment in that the step portion 42 provided in the auxiliary yoke 17 of the first embodiment is changed to a step portion 92. Other configurations remain the same as the first embodiment.

[0082] The step portion 92 is formed into a substantially L-like shape on the surface 94 of the auxiliary yoke 90 opposing to the upstanding portion 27 of the primary yoke 14 shown in Fig. 3. A recess portion 93 for holding the permanent magnet 18 is defined by forming the step portion 93 on the surface 94.

[0083] Since the step portion 92 is formed into the substantially L-like shape in the auxiliary yoke 90 of the sixth embodiment, it is possible to insert the permanent magnet 18 from one lateral side of the auxiliary yoke 90. This makes it possible to freely design the insertion step of the permanent magnet 18, e.g., to perform the insertion of the permanent magnet 18 at the final step, thereby simplifying the fabrication process.

(Seventh Embodiment)

[0084] Referring to Figs. 15A and 15B, the auxiliary yoke 100 of the seventh embodiment differs from the auxiliary yoke 17 of the first embodiment in that the step portion 42 provided in the auxiliary yoke 17 of the first embodiment is changed to a step portion 102. Other configurations remain the same as the first embodiment.

[0085] In the auxiliary yoke 100 of the seventh embodiment, the step portion 102 includes a plurality of hemispherical dowels (raised portions) formed on the surface 103 of the auxiliary yoke 100 opposing to the upstanding portion 27 of the primary yoke 14 shown in Fig. 3. By forming the step portion 102 on the surface 103, it is possible for the step portion 102 to hold the permanent magnet 18 in position.

[0086] Since the step portion 102 of the auxiliary yoke 100 of the seventh embodiment includes hemispherical dowels, it is possible to avoid reduction in the cross-sectional area of a magnetic path caused by the depth of a recess portion as compared with the case where the recess portion is formed in the auxiliary yoke.

(Eighth Embodiment)

[0087] Referring to Fig. 16, the primary yoke 14 and

the auxiliary yoke 17 of the eighth embodiment differ from those of the first embodiment in that the upstanding portion 27 of the primary yoke 14 is arranged near the bobbin 13, the auxiliary yoke 17 arranged near the operation piece 15 and the magnetic saturation portion 21 formed in the auxiliary yoke 17. Other configurations remain the same as the first embodiment.

[0088] The eighth embodiment of this configuration can provide the same advantageous effects as provided by the first embodiment set forth earlier.

[0089] The electromagnetic relay 10 according to the present invention is not limited to the first through eighth embodiments described above but may be changed or modified in many different forms.

[0090] For example, while through-holes and recess portions have been illustrated as examples of the magnetic saturation portions 21, 61, 71 and 81 in the first, third, fourth and fifth embodiments, the present invention is not limited thereto. The magnetic saturation portions may be formed in the form of slits or the like.

[0091] While the step portions 42, 92 and 102 are formed in the auxiliary yokes 17, 90 and 100 according to the first, sixth and seventh embodiments, the present invention is not limited thereto. The step portions 42, 92 and 102 may be formed in the upstanding portions 27.

[0092] The shapes and configurations of the iron core 12, the bobbin 13, the primary yoke 14, the operation piece 15, the contact point mechanism 16, the auxiliary yokes 17, 90 and 100, the permanent magnet 18, the magnetic saturation portions 21, 61, 71 and 81, the conductive coil 24, the upstanding portions 27, 60, 70 and 80, the first attracted portion 31, the second attracted portion 32, the magnetic connection portion 41, the step portions 42, 92 and 102 and the recess portion 43 employed in the first through eighth embodiments are not limited to the illustrated ones but may be appropriately changed.

[0093] While the invention has been shown and described with respect to the embodiments, it will be understood by those skilled in the art that various changes and modification may be made without departing from the scope of the invention as defined in the following claims.

Claims

1. An electromagnetic relay, comprising:

an iron core;
a bobbin arranged around the iron core and wound with a conductive coil;
a primary yoke including a base end portion connected to one end portion of the iron core and extending in the radial direction of the bobbin and an upstanding portion connected to the base end portion and arranged parallel to the iron core;

an operation piece including a first attracted portion extending along the upstanding portion and a second attracted portion movable toward or away from the other end portion of the iron core, the first attracted portion and the second attracted portion being connected to each other in a substantially L-like shape, the operation piece being arranged to swing about a tip end of the upstanding portion;

a contact point mechanism driven by the operation of the operation piece;

an auxiliary yoke extending along the upstanding portion of the primary yoke and magnetically connected to the upstanding portion through a magnetic connection portion;

a permanent magnet arranged between the upstanding portion of the primary yoke and the auxiliary yoke; and

a magnetic saturation portion provided between a portion of the upstanding portion or the auxiliary yoke, which is arranged near the first attracted portion of the operation piece, corresponding to the permanent magnet, and the magnetic connection portion,

wherein the electromagnetic relay is designed to allow the magnetic flux of the permanent magnet to flow through the upstanding portion, the operation piece, the magnetic connection portion and the auxiliary yoke when the second attracted portion is spaced apart from the other end portion of the iron core with the conductive coil kept not excited, and to flow through the upstanding portion, the operation piece, the iron core, the base end portion, the magnetic connection portion and the auxiliary yoke when the second attracted portion is attracted to the other end portion of the iron core with the conductive coil kept not excited.

2. The electromagnetic relay of claim 1, wherein the auxiliary yoke is arranged at the same side of the upstanding portion as the conductive coil and the magnetic saturation portion is provided in the upstanding portion.

3. The electromagnetic relay of claim 1 or 2, wherein the primary yoke and the auxiliary yoke are formed into a single piece.

4. The electromagnetic relay of claim 2 or 3, wherein the magnetic saturation portion is formed by reducing the cross-sectional area of a specified section of the upstanding portion.

5. The electromagnetic relay of any one of claims 2 to 4, wherein the magnetic saturation portion includes a through-hole formed in the upstanding portion.

6. The electromagnetic relay of any one of claims 1 to 5, wherein at least one of opposite surfaces of the upstanding portion and the auxiliary yoke includes a step portion for holding the permanent magnet in position.

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7. The electromagnetic relay of claim 6, wherein the step portion includes a recess portion formed in one of the upstanding portion and the auxiliary yoke.

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8. The electromagnetic relay of claim 6, wherein the step portion includes a raised portion formed in one of the upstanding portion and the auxiliary yoke.

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FIG. 1

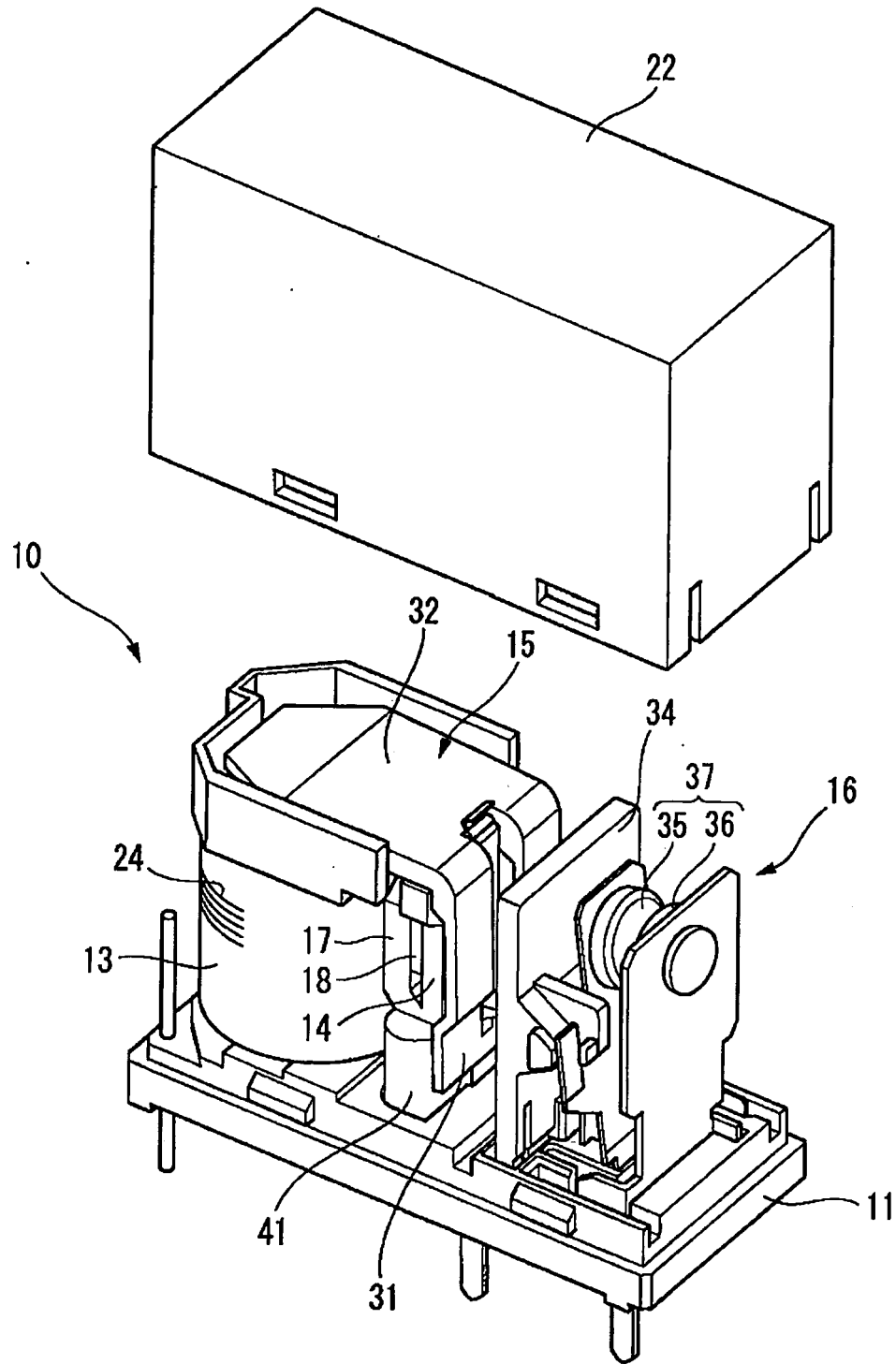


FIG. 2

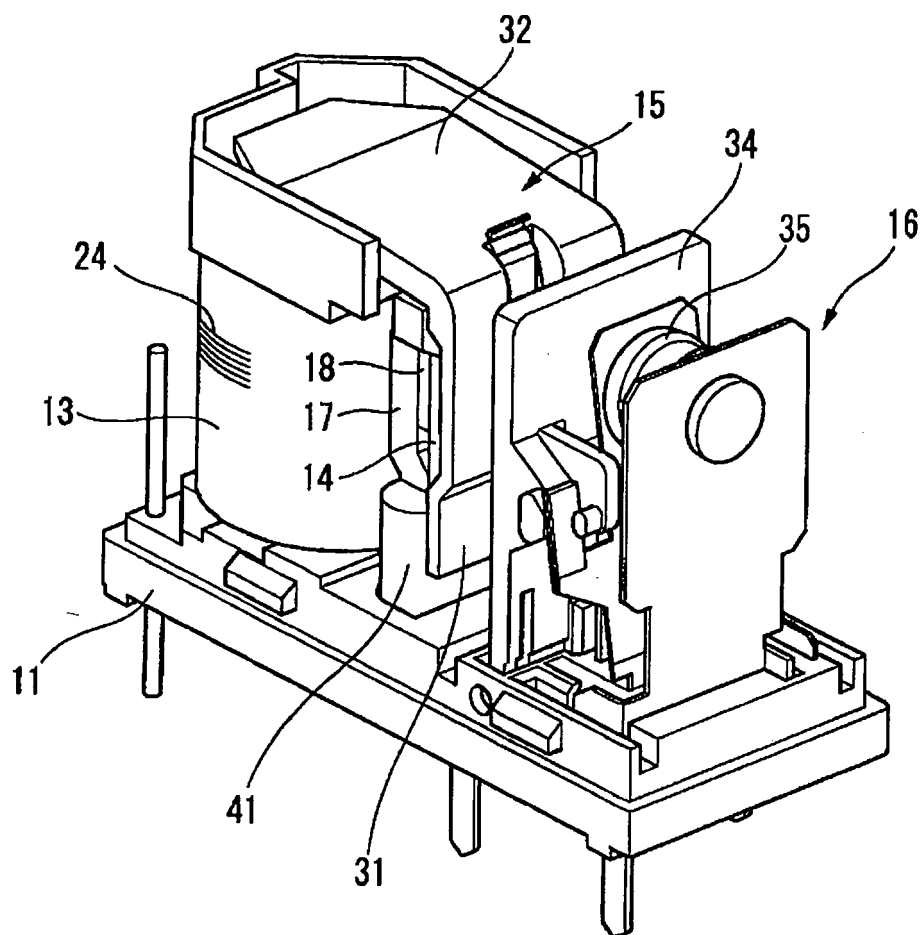


FIG. 3

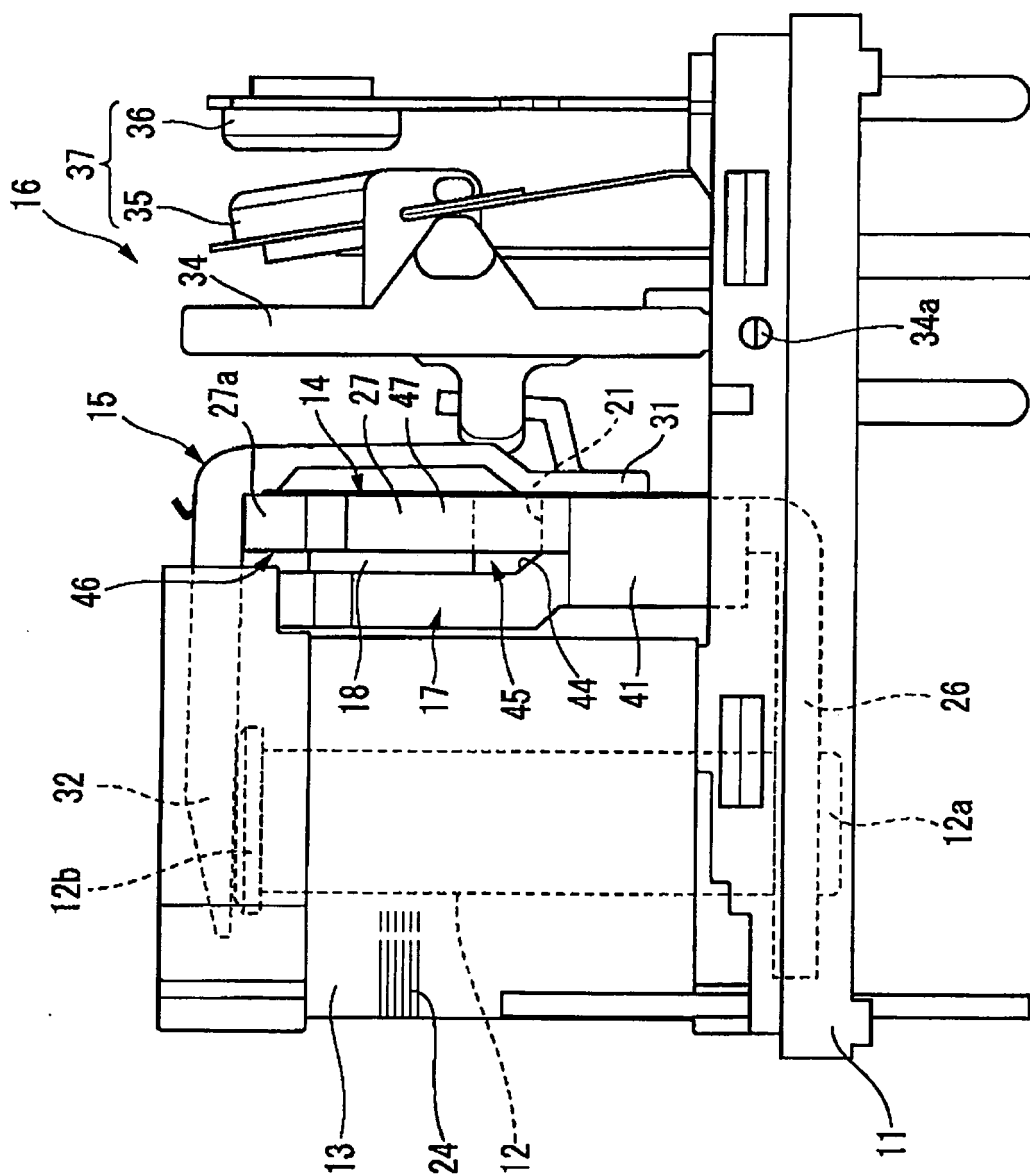


FIG. 4

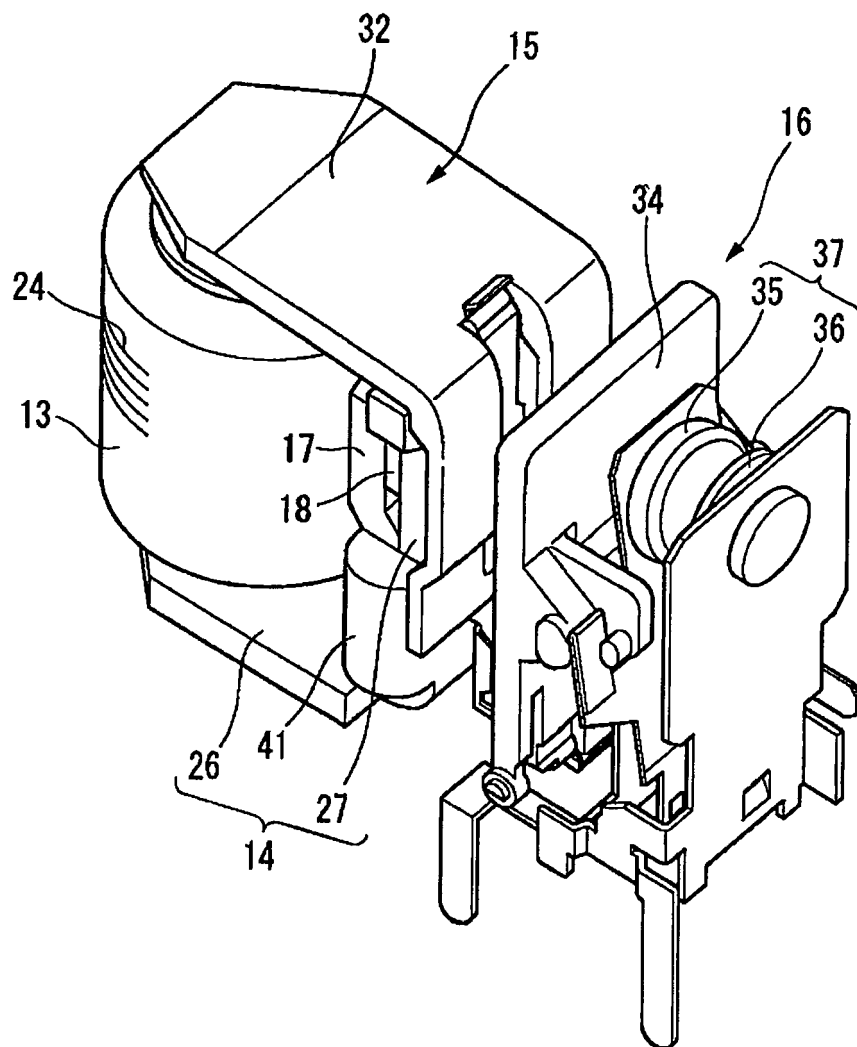


FIG. 5

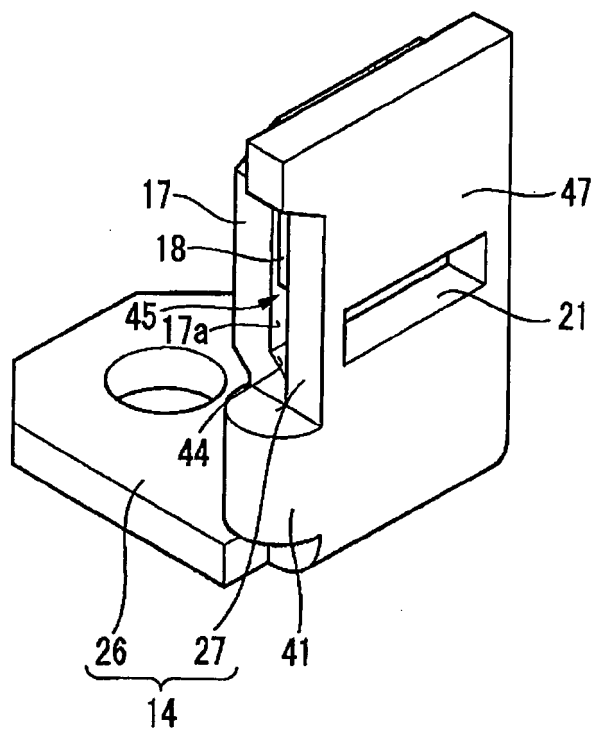


FIG. 6

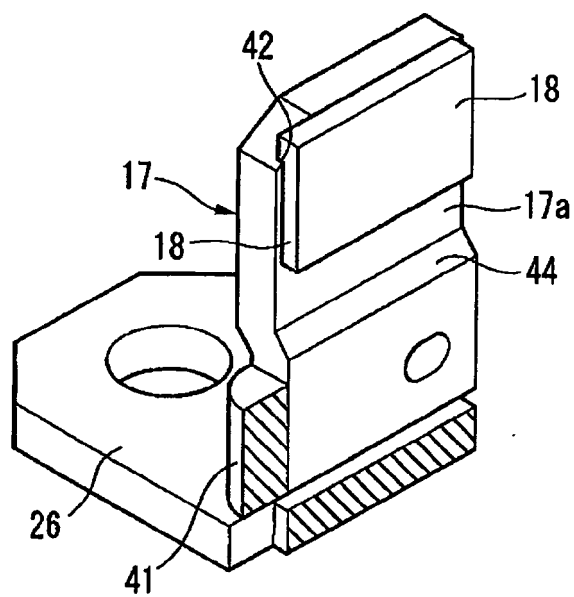


FIG. 7

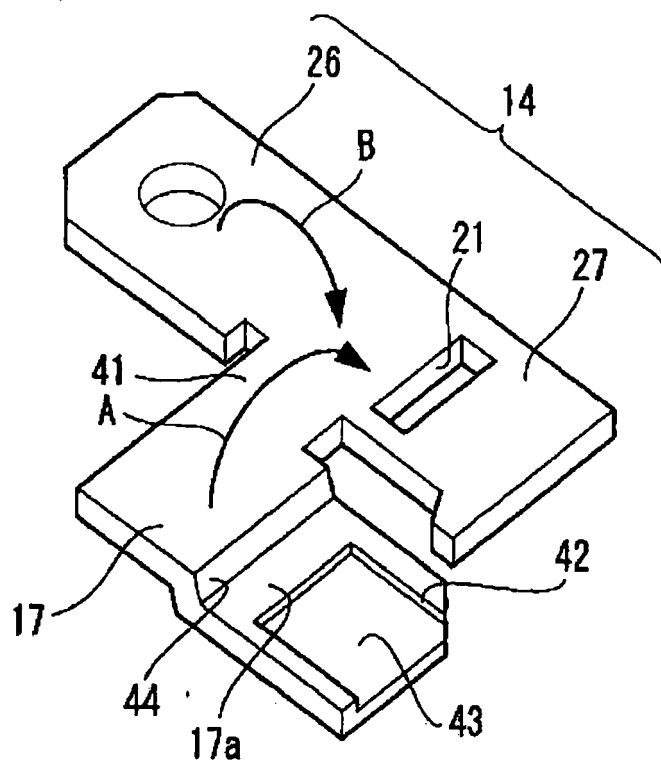
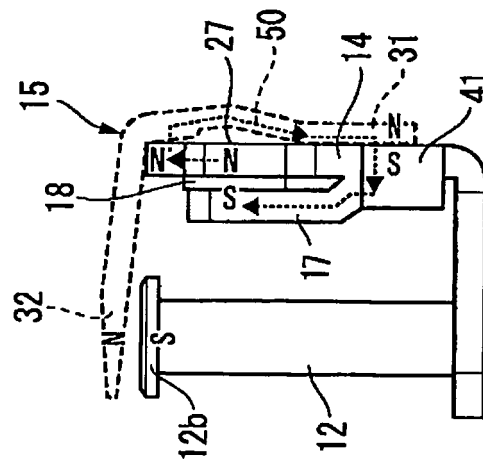
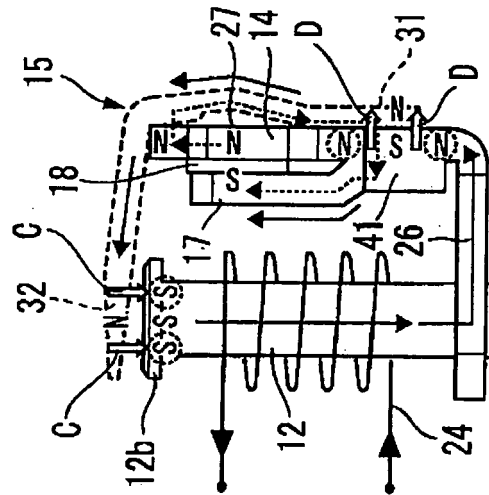


FIG. 8A



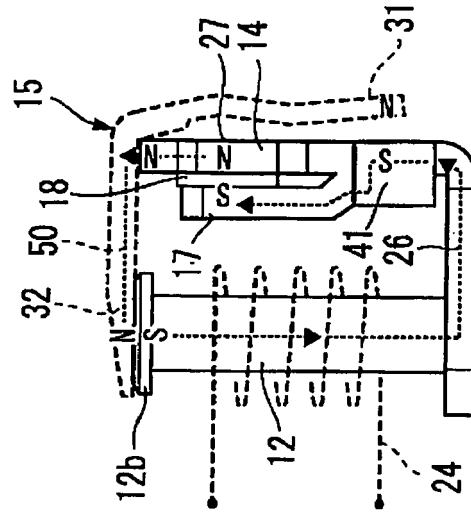
CURRENT-INTERRUPTING
STATE (NON-EXCITATION)

FIG. 8B



COIL EXCITATION
→ OPERATION START

FIG. 8C



CURRENT-FLOWING STATE
(NON-EXCITATION)

FIG. 9A

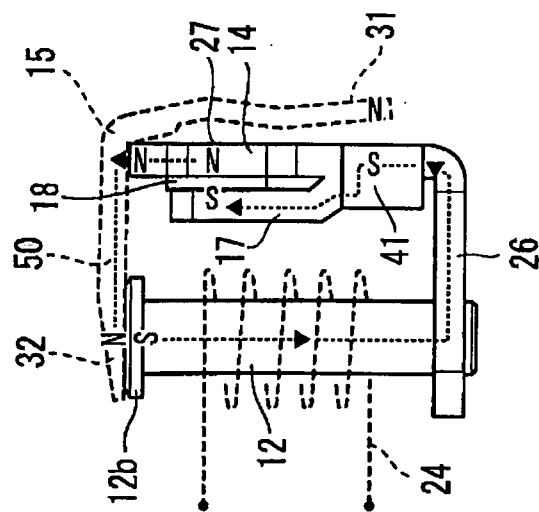


FIG. 9B

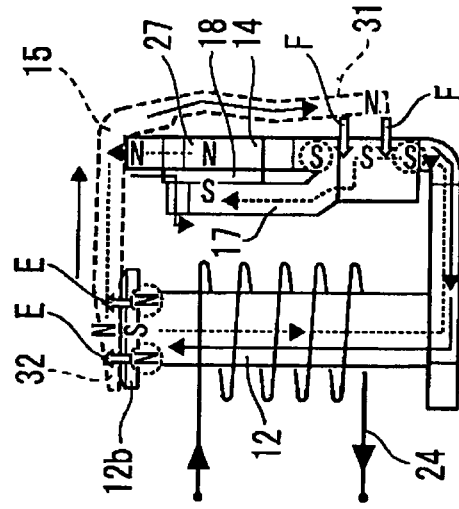


FIG. 9C

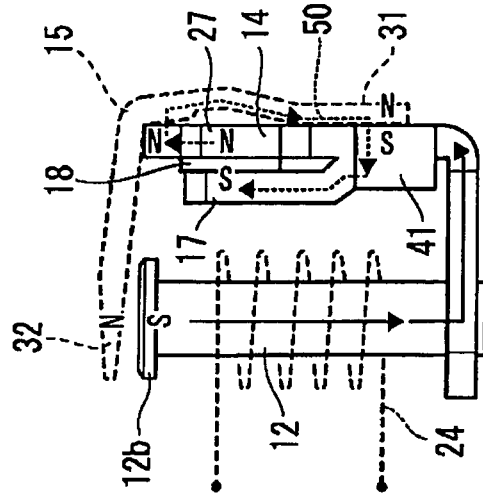


FIG. 10

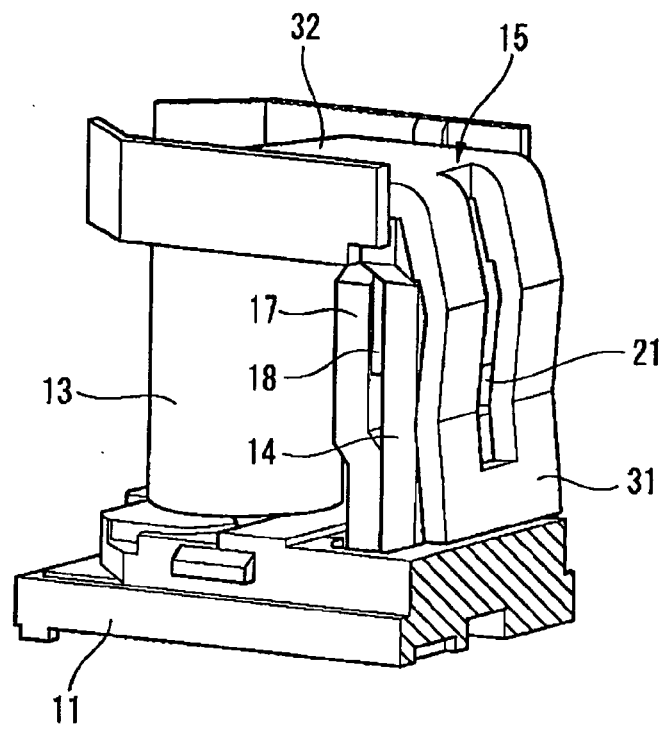


FIG. 11

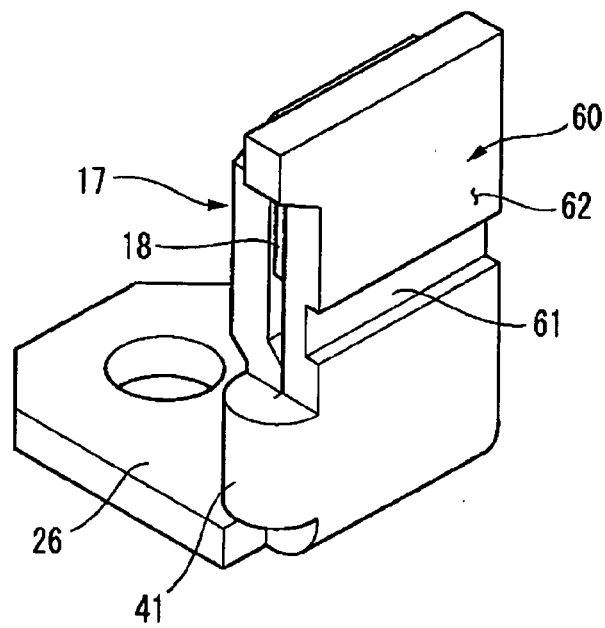


FIG. 12

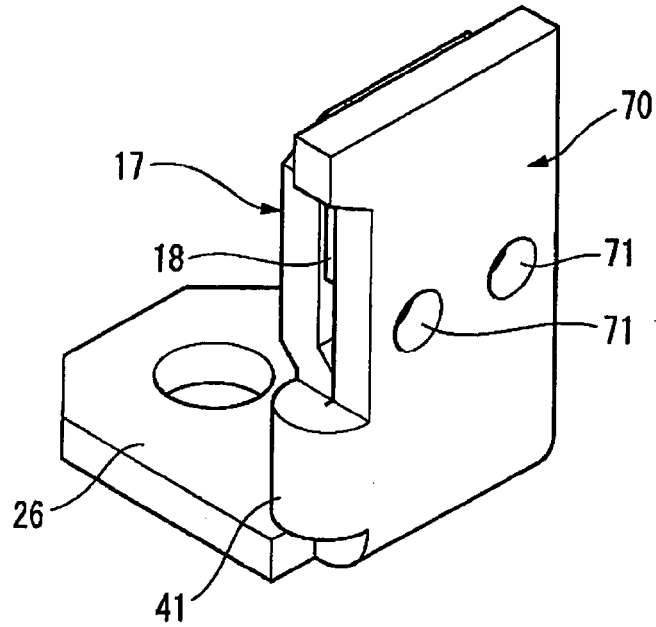


FIG. 13

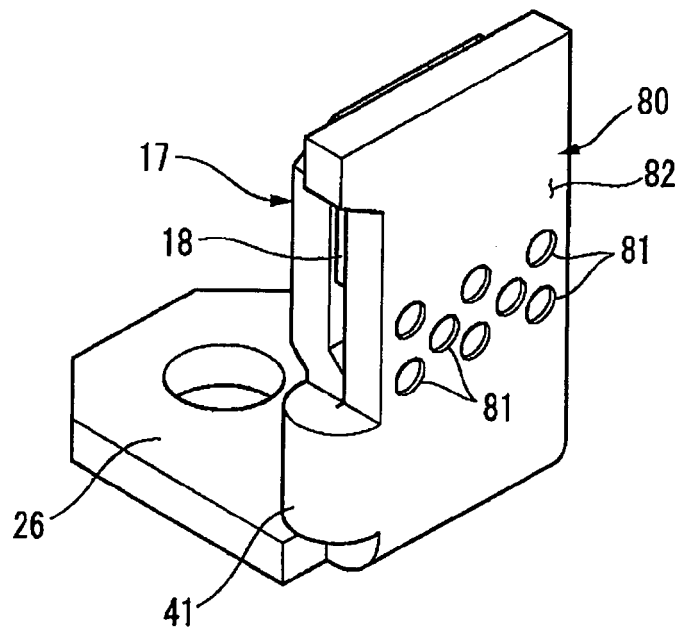


FIG. 14

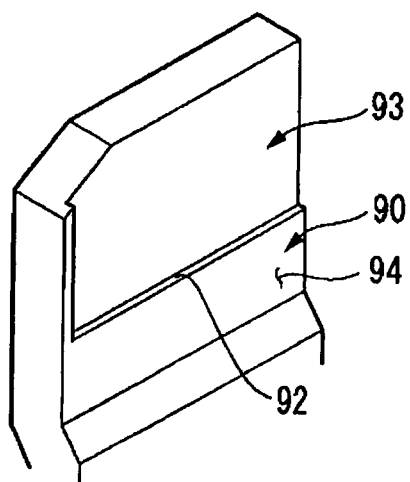


FIG. 15A

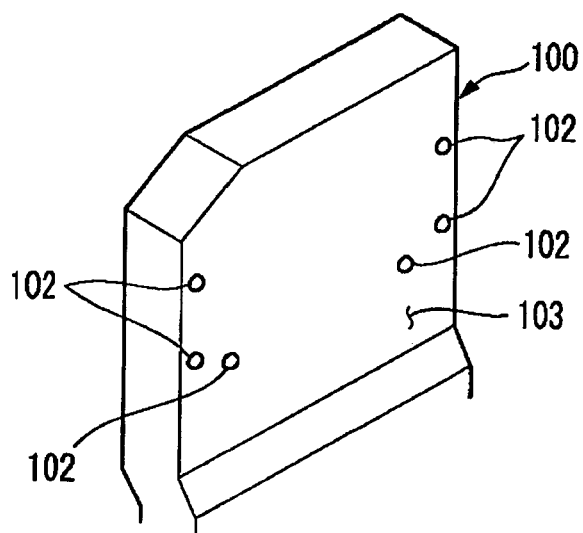


FIG. 15B

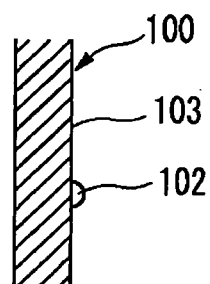
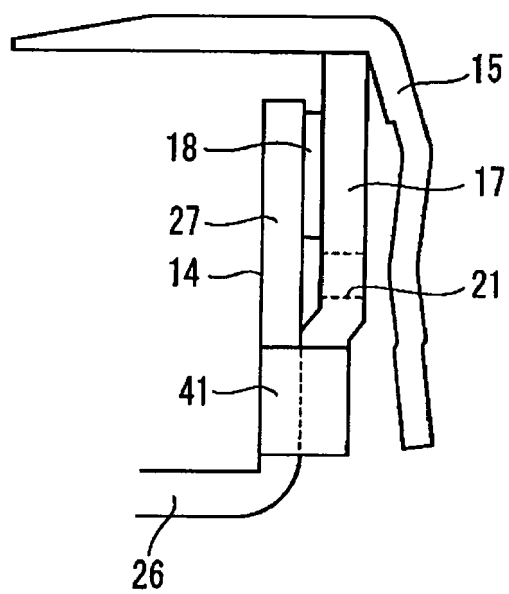


FIG. 16





EUROPEAN SEARCH REPORT

Application Number
EP 10 01 4802

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A,D	JP 2009 009710 A (PANASONIC ELEC WORKS CO LTD) 15 January 2009 (2009-01-15) * abstract; figure 3 *	1-8	INV. H01H51/27
A	DE 21 48 897 A1 (SIEMENS AG) 5 April 1973 (1973-04-05) * claim 1; figure 1 *	1	ADD. H01H50/26 H01H50/42 H01H50/64 H01H51/22
			TECHNICAL FIELDS SEARCHED (IPC)
			H01H
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 2 March 2011	Examiner Simonini, Stefano
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

1
EPO FORM 1503 03 82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 10 01 4802

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

02-03-2011

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
JP 2009009710	A	15-01-2009	NONE	

DE 2148897	A1	05-04-1973	NONE	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2009009710 A [0003] [0004] [0005]