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(54) **ELECTROMAGNETIC RELAY**

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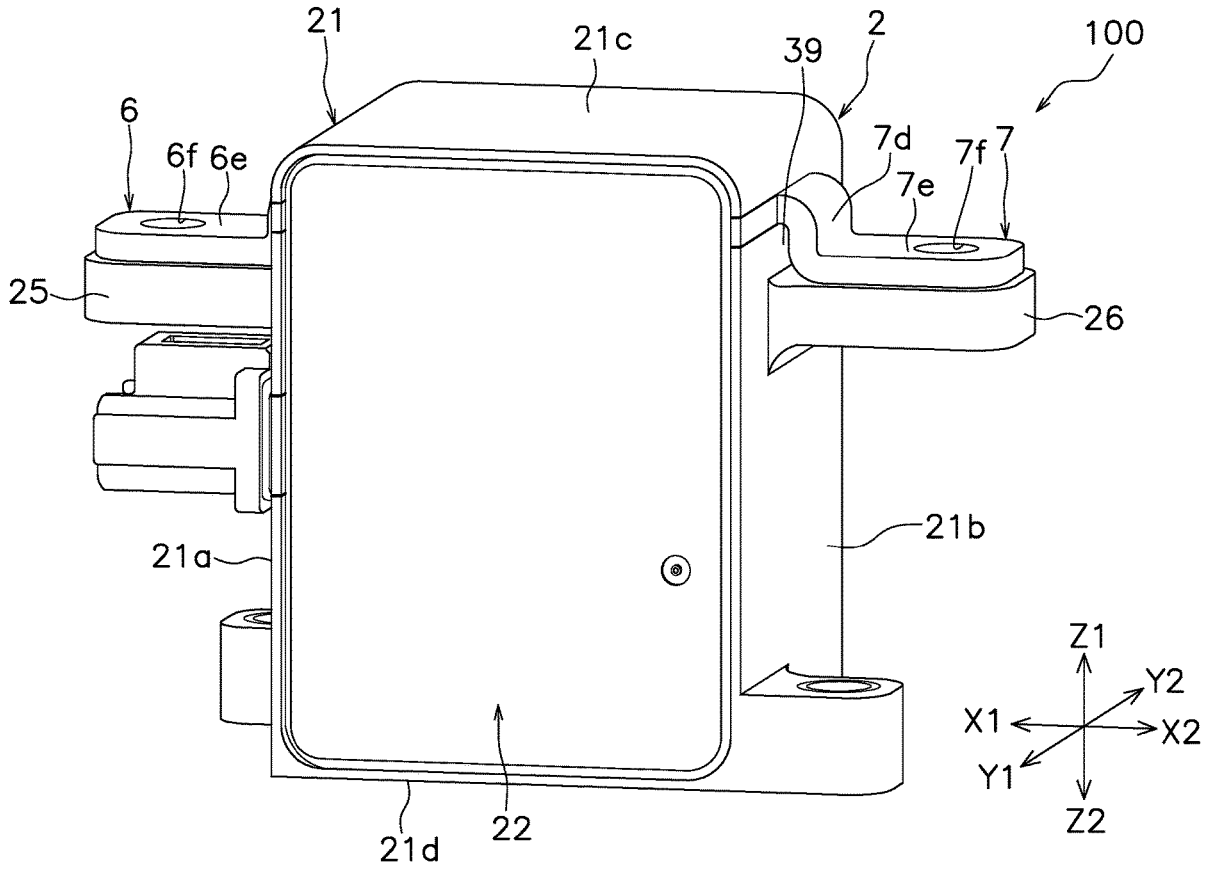
(57) **ABSTRACT**

An electromagnetic relay includes a case, a fixed terminal, and a female screw member. The fixed terminal includes an external connecting portion. The external connecting portion has a screw insertion hole, exposed to the outside from the case, and configured to be screwed to an external terminal. The female screw member is prevented from rotating by the case. The case includes a held portion that is held between the external connecting portion of the fixed terminal and the female screw member in a direction of penetration of the screw insertion hole, the direction of penetration including a first direction from the external connecting portion toward the female screw member and a second direction from the female screw member toward the external connecting portion.



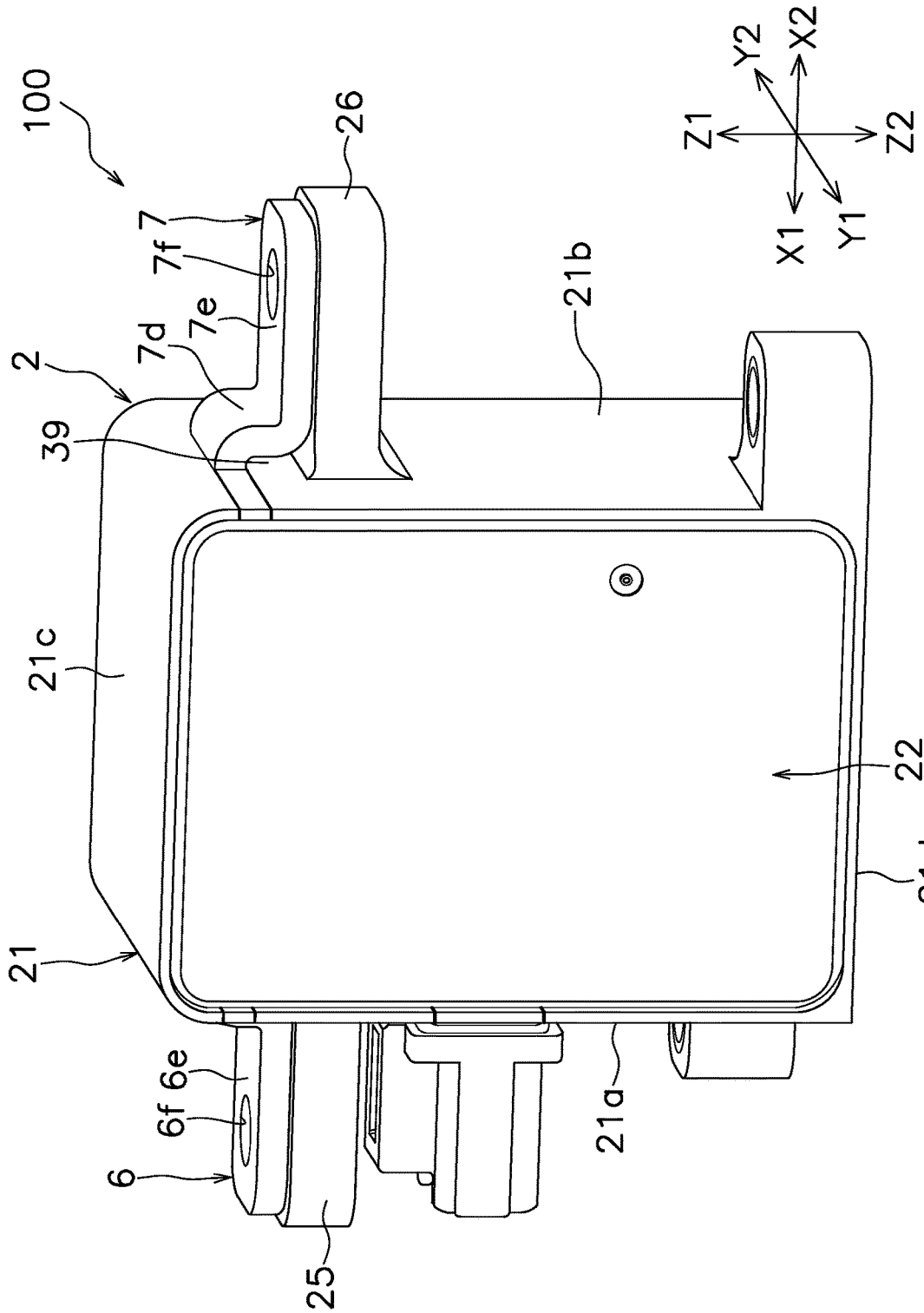

100
26
7
7f
7e
7d
2
39
21b
21c
21
22
21d
6e
6f
6
25
21a
Y2
X2
Z1
Z2
X1
Y1

FIG. 1

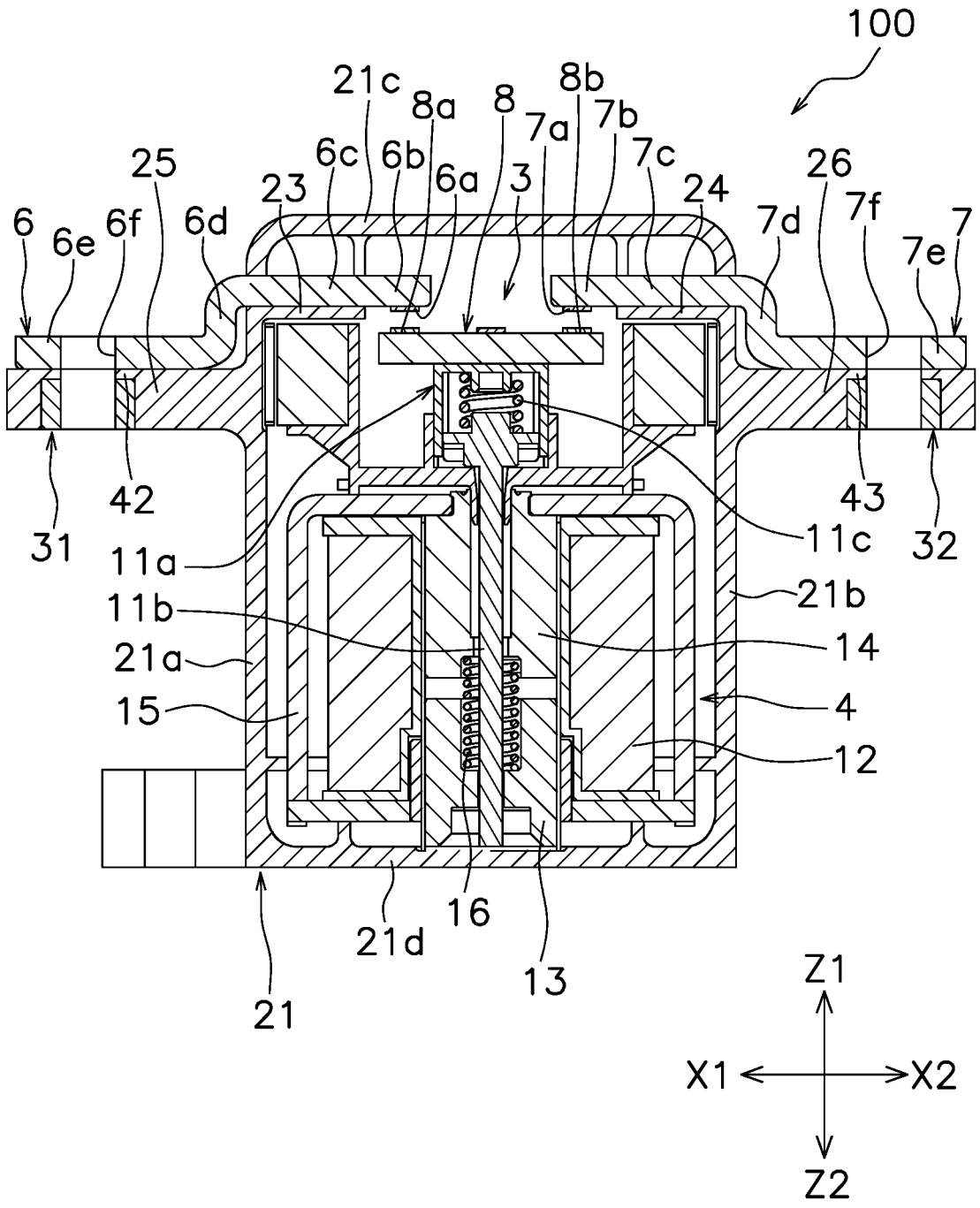

100
21c
8a
8
8b
7a
7b
6c
6b
6a
3
7c
25
23
24
26
6
6e
6f
6d
7d
7f
7
7e
42
43
31
32
11a
11c
11b
21b
14
21a
15
4
12
16
21d
13
21
Z1
X1
X2
Z2

FIG. 2

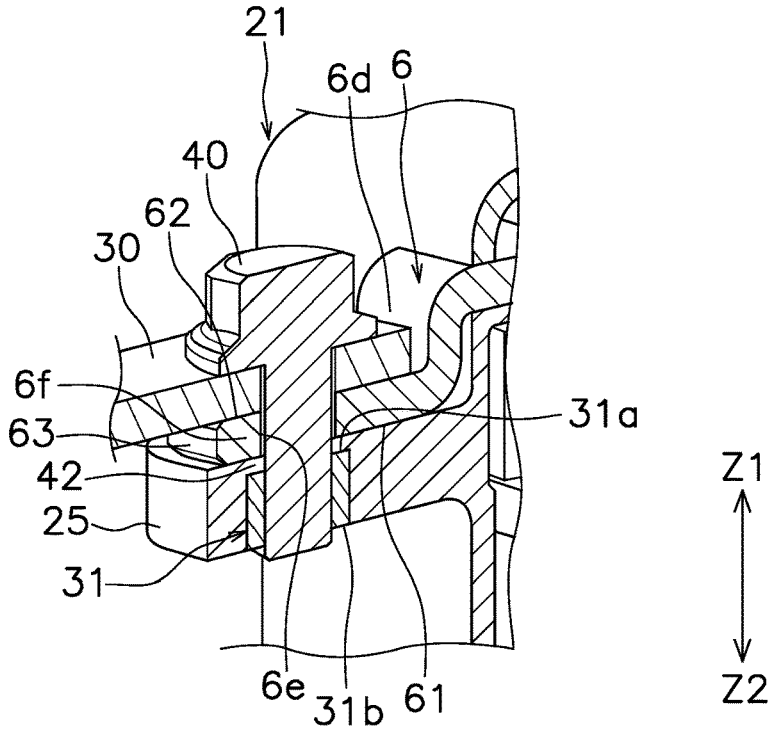

21
6d
6
40
62
30
6f
63
42
25
31
31a
6e
31b
61
Z1
Z2

FIG. 3

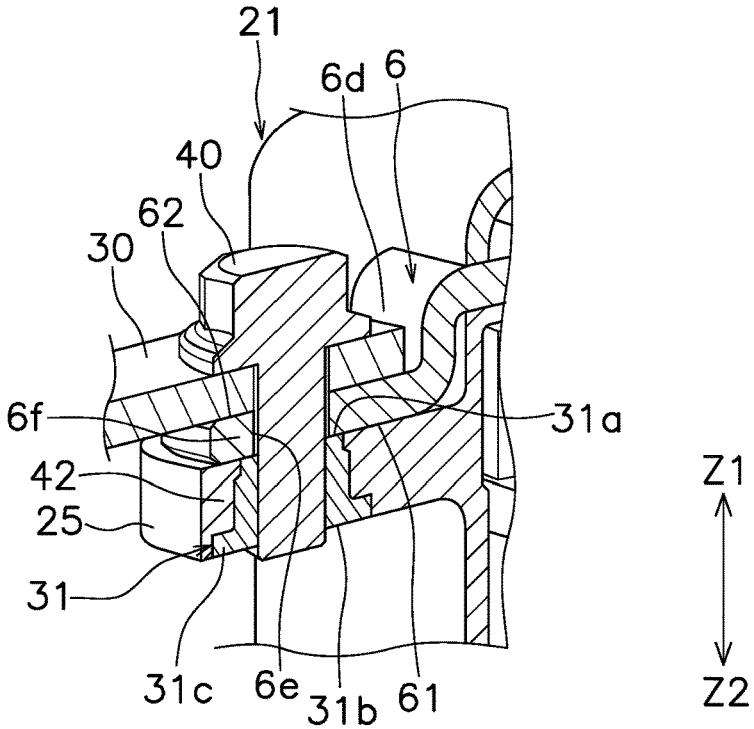

21
6d
6
40
62
30
6f
42
25
31
31a
31c
6e
31b
61
Z1
Z2

FIG. 4

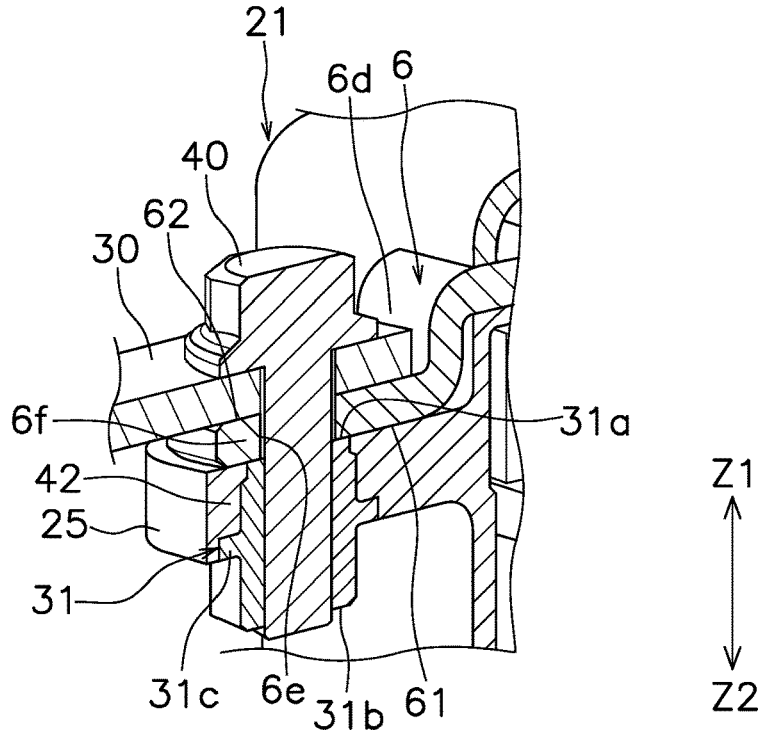

21
6d
6
40
62
30
6f
31a
42
25
31
31c
6e
31b
61
Z1
Z2

FIG. 5

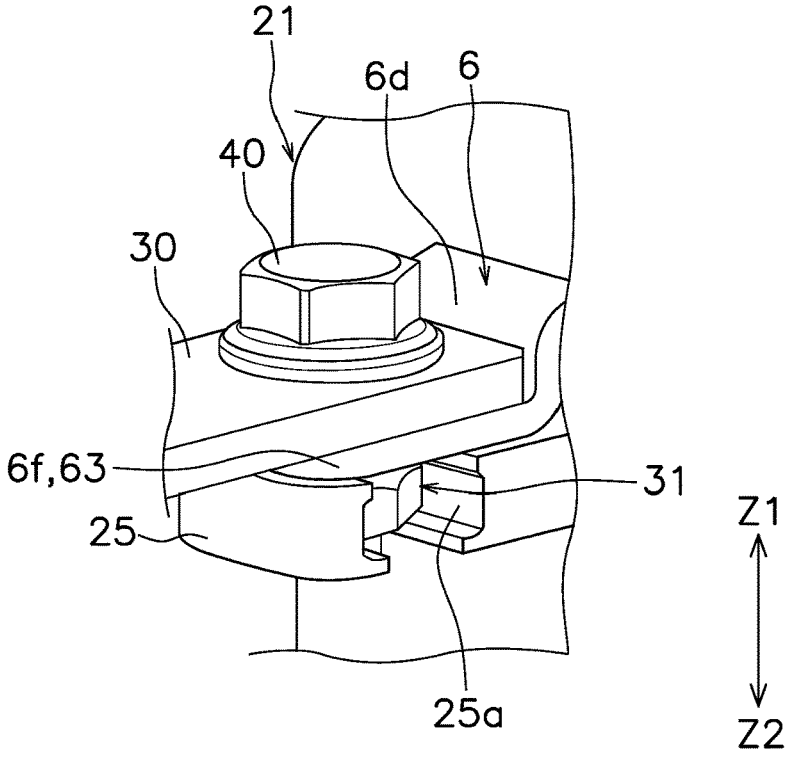

21
6d
6
40
30
6f,63
31
25
25a
Z1
Z2

FIG. 6

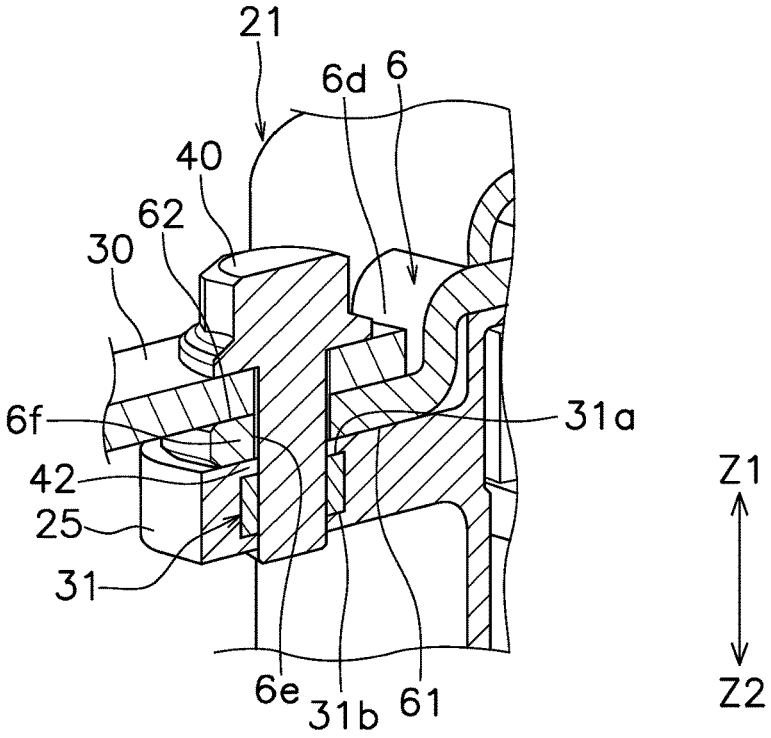


FIG. 7

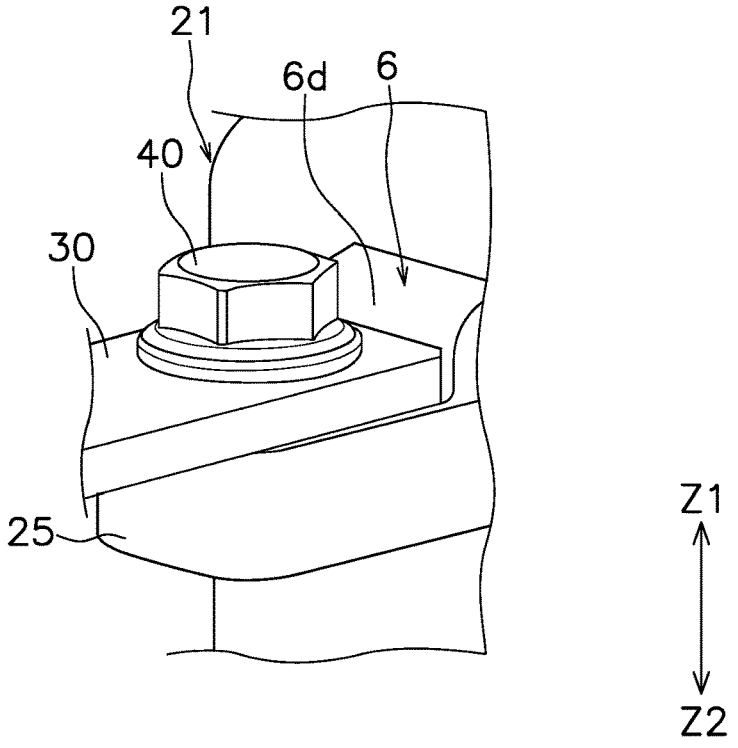


FIG. 8

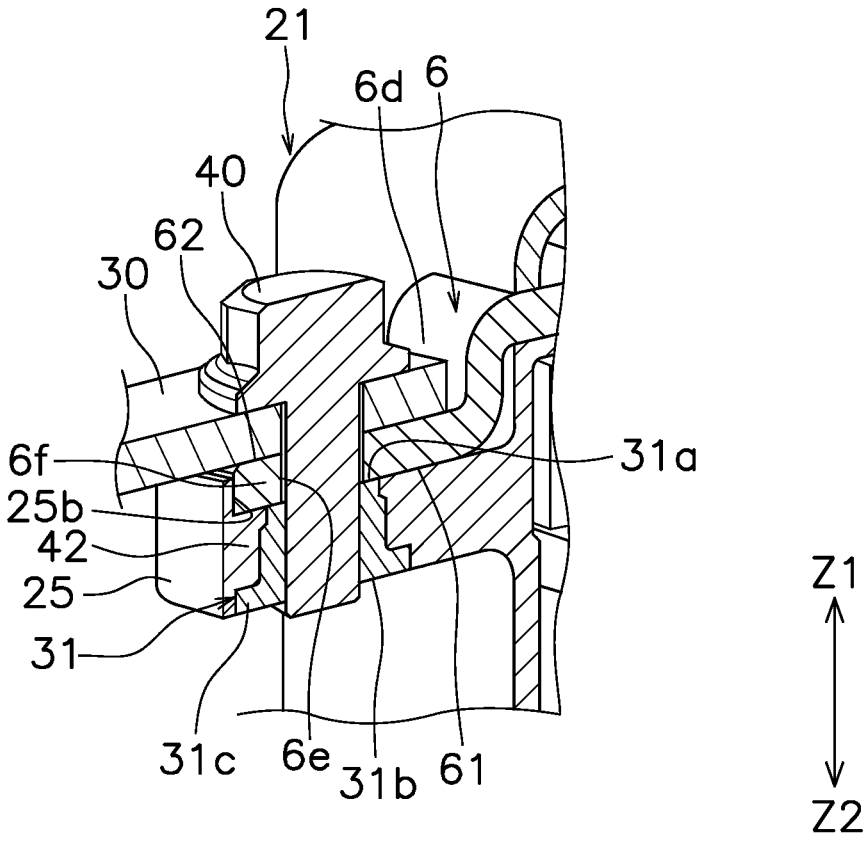


FIG. 9

ELECTROMAGNETIC RELAY

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is the U.S. National Phase of International Application No. PCT/JP2022/001497, filed on Jan. 18, 2022. This application claims priority to Japanese Patent Application No. 2021-035747, filed Mar. 5, 2021. The contents of those two applications are incorporated by reference herein in their entireties.

FIELD

[0002] The claimed invention relates to electromagnetic relays.

BACKGROUND

[0003] Conventionally, an electromagnetic relay for opening and closing an electric circuit is known. The electromagnetic relay has a fixed terminal configured to be connected to an external terminal. For example, the fixed terminal disclosed in Japanese Patent Application Publication No. 2014-049208 includes a cylindrical terminal and a plate terminal fixed to the cylindrical terminal. The plate terminal is connected to the external terminal by screw fastening.

[0004] In the electromagnetic relay of Japanese Patent Application Publication No. 2014-049208, when an external force is applied to the external terminal by screws or an accidental external force is applied to the external terminal, the plate terminal may be deformed and the function of the electromagnetic relay may be impaired.

SUMMARY

[0005] The claimed invention provides an electromagnetic relay in which the deformation of fixed terminal due to external force is decreased.

[0006] An electromagnetic relay according to one aspect of the claimed invention includes a case, a fixed terminal, and a female screw member. The fixed terminal has a plate-like shape. The fixed terminal includes an external connecting portion. The external connecting portion has a screw insertion hole, is exposed to the outside from the case, and configured to be screwed to an external terminal. The female screw member is a member for screwing the external connecting portion to the external terminal. The female screw member is prevented from rotation by the case. The case includes a held portion to be held between the external connecting portion of the fixed terminal and the female screw member in a direction of penetration of the screw insertion hole, the direction of penetration including a first direction from the female screw member toward the external connecting portion and a second direction from the external connecting portion toward the female screw member.

[0007] In this electromagnetic relay, the held portion of the case is held between the external connecting portion of the fixed terminal and the female screw member in the direction of penetration of the screw insertion hole. Thus, the external terminal, the fixed terminal, and the case are fastened together when the external terminal is screwed to the external connecting portion of the fixed terminal. With the configuration, the held portion increases the strength of the fixed terminal, and thereby deformation of the fixed terminal due to external force can be decreased. Also, the female screw member becomes less likely to come off from the case.

[0008] The female screw member may include a flange portion having an outer diameter larger than an outer diameter of an end surface of the female screw member in the first direction. The held portion of the case may be sandwiched between the external connecting portion of the fixed terminal and the flange portion of the female screw member in the direction of penetration of the screw insertion hole. In this case, the held portion is increased in size, and thereby the strength of the fixed terminal is further improved. Also, when an external terminal is screwed to the external connecting portion, damage to the case due to overtightening of the screw can be reduced.

[0009] The female screw member may have an end surface exposed to the outside from the case in the second direction. In this case, for example, the heat generated at the fixed terminal when energized can be released to the outside through the female screw member.

[0010] The case may include a case body and an outer support portion located outside the case body to be in contact with the external connecting portion. The female screw member may be positioned on the outer support portion. In this case, the external connecting portion can be supported by the outer support portion.

[0011] The external connecting portion of the fixed terminal may include a first surface contacting the held portion, a second surface opposite the first surface, and a side surface between the first surface and the second surface. The sides may be, at least partially, held by the outer support of the case. In this case, the fixed terminal can be held firmly.

[0012] The outer support portion of the case may include a retaining groove to retain the female screw member therein. The retaining groove may have an opening to insert to the female screw. The opening may be opened in a direction intersecting the direction of penetration of the screw insertion hole. In this case, the female screw member can be held by the case by a means different from insert molding.

[0013] The case may be comprised of resin. In this case, the female screw member can be fixed to the case by insert molding.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. **1** is a perspective view of an electromagnetic relay in accordance with the claimed invention.

[0015] FIG. **2** is a cross-sectional view of the electromagnetic relay illustrated in FIG. **1**.

[0016] FIG. **3** is a cross-sectional perspective view of a female screw member and surrounding components.

[0017] FIG. **4** is a cross-sectional perspective view of a female screw member and surrounding components according to a first modification.

[0018] FIG. **5** is a cross-sectional perspective view of a female screw member and surrounding components according to a second modification.

[0019] FIG. **6** is a perspective view of a female screw member and surrounding components according to a third modification.

[0020] FIG. **7** is a cross-sectional perspective view of a female screw member and surrounding components according to the third modification.

[0021] FIG. **8** is a perspective view of a female screw member and surrounding components according to a fourth modification.

[0022] FIG. **9** is a cross-sectional perspective view of a female screw member and surrounding components according to the fourth modification.

DETAILED DESCRIPTION

[0023] An embodiment of an electromagnetic relay **100** according to one aspect of the claimed invention will be described below with reference to the drawings. When referring to the drawings in the description below, the X1 direction is the leftward direction, the X2 direction is the rightward direction, the Y1 direction is the forward direction, the Y2 direction is the rearward direction, the Z1 direction is the upward direction, and the Z2 direction is the downward direction. These directions are defined for convenience of description, and do not limit the directions in which the electromagnetic relay **100** is arranged. In the present embodiment, the Z1 direction is an example of a first direction, and the Z2 direction is an example of a Second direction.

[0024] As shown in FIGS. **1** and **2**, the electromagnetic relay **100** includes a case **2**, a contact device **3**, and a driving device **4**.

[0025] The case **2** is a generally rectangular box in shape and is comprised of insulating material such as resin. In the present embodiment, the case **2** is comprised of resin. The case **2** includes a case body **21**, a lid **22**, inner support portions **23**, **24**, and outer support portions **25**, **26**.

[0026] The case body **21** has an opening at the front. The case body **21** includes a left wall **21***a*, a right wall **21***b*, an upper wall **21***c*, a lower wall **21***d*, and a rear wall (not shown). The left wall **21***a* and right wall **21***b* extend in the front-rear direction and the up-down direction. The left wall **21***a* faces the right wall **21***b* in the left-right direction. The upper wall **21***c* and the lower wall **21***d* extend in the front-rear direction and the left-right direction. The upper wall **21***c* faces the lower wall **21***d* in the up-down direction. The rear wall extends in the left-right direction and the up-down direction. The rear wall is connected to the left wall **21***a*, the right wall **21***b*, the upper wall **21***c* and the lower wall **21***d*. The lid **22** is attached to the case body **21** so as to close the opening of the case body **21**.

[0027] The inner support portion **23** protrudes rightward from an inner surface of the left wall **21***a*. The inner support portion **24** protrudes leftward from an inner surface of the right wall **21***b*. The inner support portions **23**, **24** each have a flat upper surface. That is, the upper surfaces of the inner support portions **23**, **24** include a plane perpendicular to the up-down direction.

[0028] The outer support portion **25** is disposed outside the case body **21**. The outer support portion **25** protrudes leftward from an outer surface of the left wall **21***a*. The outer support portion **25** is disposed below the inner support portion **23**. The outer support portion **26** protrudes rightward from an outer surface of the right wall **21***b*. The outer support portion **26** is disposed below the inner support portion **24**. The outer support portions **25** and **26** each have a flat upper surface. That is, the upper surfaces of the outer support portions and **26** include a plane perpendicular to the up-down direction.

[0029] The contact device **3** includes fixed terminals **6** and **7** and a movable contact piece **8**. The fixed terminals **6** and **7** may be plate terminals and are comprised of conductive material. The fixed terminals **6** and **7** extend in the left-right direction and have a bent shape. The fixed terminals **6** and **7** extend across the interior and exterior of the case **2**. The fixed terminals **6** and **7** are arranged apart from each other in the left-right direction. The fixed terminals **6** and **7** are held by the case **2**.

[0030] The fixed terminal **6** includes a fixed contact **6***a*, a contact support portion **6***b*, an extension portion **6***c*, a bent portion **6***d*, an external connecting portion **6***e*, and a screw insertion hole **6***f*. The fixed contact **6***a* is disposed inside the case **2**. The fixed contact **6***a* is disposed facing the movable contact piece **8** in the up-down direction. The fixed contact **6***a* is disposed on the lower surface of the contact support portion **6***b*. The contact support portion **6***b* supports the fixed contact **6***a*.

[0031] The extension portion **6***c* extends leftward from the contact support portion **6***b*. The extension portion **6***c* is supported on the upper surface of the inner support portion **23**. The bent portion **6***d* is arranged outside the case **2**. The bent portion **6***d* is connected to the extension portion **6***c*. The bent portion **6***d* extends in the up-down direction. The bent portion **6***d* extends in a bending form in the Z2 direction from the left end of the extension portion **6***c*.

[0032] The external connecting portion **6***e* is exposed to the outside from the case **2**. The external connecting portion **6***e* is connected to the bent portion **6***d*. The external connecting portion **6***e* extends leftwards from the bent portion **6***d*. The external connecting portion **6***e* is to be in contact with the upper surface of the outer support portion **25**. The external connecting portion **6***e* is to be connected to an external terminal **30** (see FIG. **3**) such as a busbar by screwing.

[0033] The screw insertion hole **6***f* is located in the external connecting portion **6***e*. The screw insertion hole **6***f* penetrates through the external connecting portion **6***e* in the up-down direction. In the present embodiment, the direction of penetration of the screw insertion hole **6***f* coincides with the up-down direction. Thus, the direction of penetration of the screw insertion hole **6***f* encompasses the Z1 direction from the female screw member **31** to the external connecting portion **6***e* and the Z2 direction from the external connecting portion **6***e* to the female screw member **31**, which will be described later.

[0034] The fixed terminal **7** is bilaterally symmetric with the first fixed terminal **6**, so detailed description thereof will be omitted. The fixed terminal **7** includes a fixed contact **7***a*, a contact support portion **7***b*, an extending portion **7***c*, a bent portion **7***d*, an external connecting portion **7***e*, and a screw insertion hole **7***f*. The fixed contact **7***a* is arranged to face the movable contact piece **8** in the up-down direction at a position spaced from the fixed contact **6***a* in the left-right direction. The contact support portion **7***b* supports the fixed contact **7***a*. The extending portion **7***c* is supported on the upper surface of the inner support portion **24**. The bent portion **7***d* extends in the up-down direction outside the case **2**. The external connecting portion **7***e* extends in the left-right direction and is supported on the upper surface of the outer support portion **26**.

[0035] The external connecting portion **7***e* is to be connected to an external terminal (not shown) such as a busbar by screwing. The screw insertion hole **7***f* penetrates through the external connecting portion **7***e* in the up-down direction.

[0036] The movable contact piece **8** is a plate terminal elongated in one direction and comprised of conductive material. The movable contact piece **8** is located inside the case **2**. The movable contact piece **8** extends in the left-right direction inside the case **2**.

[0037] The movable contact piece **8** includes movable contacts **8***a*, **8***b*. The movable contact **8***a* is disposed to face the fixed contact **6***a*. The movable contact **8***b* is disposed to face the fixed contact **7***a*.

[0038] The movable contact piece **8** is movable in the up-down direction. That is, the movable contact piece **8** is movable in the Z**1** direction and the Z**2** direction. In the present embodiment, the Z**1** direction coincides with the direction from the movable contact **8***a* toward the fixed contact **6***a*. The Z**2** direction coincides with the direction from the fixed contact **6***a* toward the movable contact **8***a*.

[0039] The driving device **4** is positioned inside the case **2**. The driving device **4** is configured to move the movable contact piece **8** in the Z**1** direction and the Z**2** direction. The driving device **4** includes a movable mechanism **11**, a coil **12**, a movable iron core **13**, a fixed iron core **14**, a yoke **15**, and a return spring **16**.

[0040] The movable mechanism **11** is connected to the movable contact piece **8**. As shown in FIG. **4**, the movable mechanism **11** includes a holder **11***a*, a drive shaft **11***b*, and a contact spring **11***c*. The holder **11***a* holds the movable contact piece **8**. The holder **11***a* is configured to move integrally with the movable contact piece **8**. The drive shaft **11***b* extends in the up-down direction. The drive shaft **11***b* is arranged below the movable contact piece **8**. The drive shaft **11***b* is connected to the holder **11***a* so as to be relatively movable in the up-down direction with respect to the holder **11***a*. The contact spring **11***c* is arranged between the holder **11***a* and the drive shaft **11***b*. The contact spring **11***c* urges the movable contact piece **8** in the Z**1** direction via the holder **11***a*.

[0041] When a voltage is applied to the coil **12** to excite it, the coil **12** generates an electromagnetic force that causes the movable iron core **13** to move in the Z**1** direction. The movable iron core **13** is fixed to the drive shaft **11***b* so as to be movable integrally therewith. The fixed iron core **14** is disposed above the movable iron core **13** so as to face the movable iron core **13**. The yoke **15** is arranged to surround the coil **12**. The yoke **15** is connected to the fixed iron core **14**. The return spring **16** urges the movable iron core **13** in the Z**2** direction.

[0042] The electromagnetic relay **100** further includes a female screw member **31**. The female screw member **31** is supported by the case **2**. The female screw member **31** is a member for screwing the external connecting portion **6***e* to the external terminal **30**. The female screw member **31** in the present embodiment is, for example, a hexagonal nut. The female screw member **31** is prevented from rotating by the case **2**. In the present embodiment, the female screw member **31** is fixed to the case **2** by insert molding.

[0043] FIG. **3** is a cross-sectional perspective view of the female screw member **31** and the region around it. As shown in FIGS. **2** and **3**, the female screw member **31** is positioned in the outer support portion **25**. The female screw member **31** is embedded in the outer support portion **25**. The female screw member **31** overlaps the external connecting portion **6***e* when viewed from the direction of penetration of the screw insertion hole **6***f*. As shown in FIG. **3**, the female screw member **31** is to be screwed to a male screw member **40** that is inserted through the screw insertion hole **6***f*. The male screw member **40** may, for example, be a bolt.

[0044] The female screw member **31** is in contact with the external connecting portion **6***e* via the outer support portion **25** in the direction of penetration of the screw insertion hole **6***f*. Specifically, the case **2** further includes a held portion **42**. The held portion **42** is held between the external connecting portion **6***e* and the female screw member **31** in the direction of penetration of the screw insertion hole **6***f*. The held portion **42** extends in the up-down direction. The held portion **42** is constituted by part of the outer support portion **25**. The held portion **42** overlaps the external connecting portion **6***e* and the female screw member **31** in the direction of penetration of the screw insertion hole **6***f*. The held portion **42** is pressed in the Z**1** and Z**2** directions when the external connecting portion **6***e* is screwed to the external terminal **30**. The held portion **42** may be pressed in the Z**2** direction by the external connecting portion **6***e* when the external connecting portion **6***e* is not screwed to the external terminal **30**.

[0045] The female screw member **31** includes end surfaces **31***a* and **31***b*. The end surface **31***a* is the end surface in the Z**1** direction and is in contact with the held portion **42**. The end surface **31***b* is an end surface in the Z**2** direction and is exposed to the outside from the external connecting portion **6***e* of the case **2**. The end surface **31***b* is arranged flush with the lower surface of the external connecting portion **6***e*.

[0046] The external connecting portion **6***e* includes a first surface **61**, a second surface **62** opposite the first surface **61**, and a side surface **63** between the first surface **61** and the second surface **62**. The first surface **61** is the lower surface of the external connecting portion **6***e* and is in contact with the outer support portion **25** and the held portion **42**. The second surface **62** is the upper surface of the external connecting portion **6***e* and is in contact with the external terminal **30**.

[0047] In the electromagnetic relay **100** configured as described above, the held portion **42** of the case **2** is held between the external connecting portion **6***e* of the fixed terminal **6** and the female screw member **31** in the direction of penetration of the screw insertion hole **6***f*. Thus, when the external terminal is screwed to the external connecting portion **6***e* of the fixed terminal **6**, the external terminal **30**, the fixed terminal **6** and the case **2** are fastened together. With the configuration, the held portion **42** increases the strength of the fixed terminal **6**, thereby decreasing the deformation of the fixed terminal **6** due to external force. In addition, the female screw member **31** becomes less likely to come off from the case **2**.

[0048] Note that the electromagnetic relay **100** further includes a female screw member **32**, as shown in FIG. **2**. The case **2** further includes a held portion **43**. The held portion **43** is held between the external connecting portion **7***e* and the female screw member **32** in the direction of penetration of the screw insertion hole **7***f*. Thus, when an external terminal (not shown) is screwed to the external connecting portion **7***e* of the fixed terminal **7**, the external terminal, the fixed terminal **7** and the case **2** are fastened together.

[0049] An embodiment of the electromagnetic relay according to one aspect of the claimed invention has been described above, but the claimed invention is not limited to the above embodiment, and various modifications can be made without departing from the scope of the invention.

[0050] FIG. **4** is a cross-sectional perspective view illustrating a female screw member **31** and the surrounding region according to a first modification. The female screw member **31** includes a flange portion **31***c*. The flange portion **31***c* has an outer diameter greater than the outer diameter of the end surface **31***a* of the female screw member **31**. The flange portion **31***c* includes an end surface **31***b*. The flange portion **31***c* is in contact with the held portion **42** in the direction of penetration of the screw insertion hole **6***f*. The held portion **42** is held between the external connecting portion **6***e* and the flange portion **31***c* in the direction of penetration of the screw insertion hole **6***f*. In the first modification, the end surface **31***a* is in contact with the first surface **61** of the external connecting portion **6***e*. Note that the end surface **31***a* does not have to be in contact with the first surface **61**.

[0051] FIG. **5** is a cross-sectional perspective view illustrating the female screw member **31** and the surrounding region according to a second modification. In the second modification, the female screw member **31** protrudes in the Z**2** direction beyond the outer support portion **25**. The threaded hole of the female screw member **31** protrudes in the Z**2** direction beyond the outer support portion **25**. That is, the lower portion of the female screw member **31** is exposed to the outside from the external connecting portion **6***e*. Other configurations are similar to those of the first modification.

[0052] FIG. **6** is a perspective view illustrating the female screw member **31** and the surrounding region according to a third modification. FIG. **7** is a cross-sectional perspective view of the female screw member **31** and the surrounding region according to the third modification. In the third modification, the outer support portion **25** includes a retaining groove **25***a*. The retaining groove **25***a* retains the female screw member **31** from rotating. The female screw member **31** is inserted into the retaining groove **25***a* from a direction intersecting the direction of penetration of the screw insertion hole **6***f*. Here, the retaining groove **25***a* is open forward, and the female screw member **31** is inserted from the front. The end surface **31***b* of the female screw member **31** is supported by the retaining groove **25***a*. Thus, the end surface **31***b* of the female screw member **31** is, at least partially, covered with the retaining groove **25***a*.

[0053] FIG. **8** is a perspective view illustrating the female screw member **31** and the surrounding region according to a fourth modification. FIG. **9** is a cross-sectional perspective view illustrating the female screw member **31** and the surrounding region according to the fourth modification. In the fourth modification, the side surface **63** of the external connecting portion **6***e* is, at least partially, held on the outer support portion **25**. Specifically, the outer support portion **25** includes a retaining groove **25***b* for retaining the side surface **63**. The retaining groove **25***b* is formed along the shape of the side surface **63**. The retaining groove **25***b* covers the left side, the front side, and the rear side of the side surface **63**. Other configurations are similar to those of the first modification. Note that the outer support portion **25** may have a shape partially covering the upper surface of the external connecting portion **6***e*.

REFERENCE NUMERALS

[0054] **2** Case
[0055] **6** Fixed terminal
[0056] **6***e* External connecting portion
[0057] **6***f* Screw insertion hole
[0058] **21** Case body
[0059] Outer support portion
[0060] **25***a* Retaining groove
[0061] **31** Femail screw member
[0062] **31***c* Flange portion
[0063] **42** Held portion
[0064] **61** first surface
[0065] **62** Second surface
[0066] **63** Side
[0067] **100** Electromagnetic relay

1. An electromagnetic relay, comprising:

a case;

a fixed terminal having a plate-like shape, the fixed terminal including an external connecting portion, the external connecting portion having a screw insertion hole that is exposed to an outside from the case, the external connecting portion being configured to be screwed to an external terminal; and

a female screw member prevented from rotating by the case, the female screw member being configured to screw the external connecting portion to the external terminal,

the case including a held portion configured to be held between the external connecting portion of the fixed terminal and the female screw member in a direction of penetration of the screw insertion hole, the direction including a first direction from the female screw member toward the external connecting portion and a second direction from the external connecting portion toward the female screw member.

2. The electromagnetic relay according to claim **1**, wherein

the female screw member includes a flange portion having an outer diameter larger than an outer diameter of an end surface of the female screw member in the first direction, and

the held portion of the case is held between the external connecting portion of the fixed terminal and the flange portion of the female screw member in the direction of penetration of the screw insertion hole.

3. The electromagnetic relay according to claim **1**, wherein the female screw member has an end surface exposed to the outside from the case in the second direction.

4. The electromagnetic relay according to claim **1**, wherein

the case includes a case body and an outer support portion located outside the case body to be in contact with the external connecting portion, and

the female screw member is disposed in the outer support portion.

5. The electromagnetic relay according to claim **4**, wherein

the external connecting portion of the fixed terminal includes a first surface contacting the held portion, a second surface opposite the first surface, and a side surface between the first surface and the second surface, and

the side surface is, at least partially, held by the outer support portion of the case.

6. The electromagnetic relay according to claim **4**, wherein

the outer support portion of the case includes a retaining groove to retain the female screw member, the retaining groove having an opening to insert to the female screw, the opening opened

in a direction intersecting the direction of penetrating of the screw insertion hole.

7. The electromagnetic relay according to claim **1**, wherein the case is comprised of resin.

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