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Inventor(s)	OGAWA; Shinichi et al.

ELECTROMAGNETIC RELAY

Abstract

An electromagnetic relay includes a fixed contact, a fixed terminal, a movable contact, a movable contact piece, and a housing. The fixed terminal includes an outer terminal portion and a contact support portion. The housing includes a body, a cover, an adhesive, and a support portion. The body has an opening. The cover closes the opening. The adhesive bonds the body to the cover. The support portion protrudes laterally from the body. The support portion is disposed below and supports the outer terminal portion of the fixed terminal. The support portion includes a support surface and a connection portion. The support surface is in contact with the outer terminal portion of the fixed terminal. The connection portion is disposed between the support surface and the body and is connected to the body with a gap between it and the outer terminal portion of the fixed terminal.

Inventors: **OGAWA; Shinichi (Kyoto-shi, Kyoto, JP), MINOWA; Ryota (Kyoto-shi, Kyoto, JP)**

Applicant: **OMRON Corporation** (Kyoto-shi, Kyoto, JP)

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application is the U.S. National Phase of International Application No. PCT/JP2023/000916, filed on Jan. 16, 2023. This application claims priority to Japanese Patent Application No. 2022-060455, filed Mar. 31, 2022. The contents of both of those applications are incorporated by reference herein in their entireties.

FIELD

[0002] The claimed invention relates to an electromagnetic relay.

BACKGROUND

[0003] Some electromagnetic relays have a fixed terminal protruding laterally from the housing. For example, the electromagnetic relay of Japan Patent Application Publication No. 2010-10055 includes a fixed terminal protruding from the side surface of the housing. The housing includes a support portion protruding from the side surface. The support portion supports the fixed terminal. A nut is connected to the fixed terminal, and a bolt is enmeshed in the nut. The bolt and the nut secure a connecting member such as a bus bar to the fixed terminal.

[0004] When fixing the connecting member to the fixed terminal, the torque from bolting is transmitted to the housing via the support portion. Therefore, the housing must have high strength against torque from bolting. For example, some electromagnetic relays have a housing that includes a case and a cover, and the case and the cover are bonded together by an adhesive. In such an electromagnetic relay, a large torque applied to the housing by bolting may affect the adhesive bonding.

SUMMARY

[0005] An object of the claimed invention is to improve the strength of the housing against torque due to bolting. An embodiment of an electromagnetic relay in accordance with the claimed invention includes a fixed contact, a fixed terminal, a movable contact, a movable contact piece, and a housing. The fixed terminal has a plate shape. The fixed terminal includes an outer terminal portion and a contact support portion. The contact support portion is connected to the fixed contact. The movable contact faces the fixed contact. The movable contact piece is connected to the movable contact. The housing includes a body, a cover, an adhesive, and a support portion. The body includes an opening. The body houses the contact support, the fixed contact, the movable contact, and the movable contact piece. The cover is attached to the body. The cover closes the opening. The adhesive bonds the body to the cover. The support portion protrudes laterally from the body. The support portion is disposed below the outer terminal portion of the fixed terminal. The outer terminal protrudes laterally from the body. The support portion supports the outer terminal portion of the fixed terminal. The support portion includes a support surface and a connection portion. The support surface is in contact with the outer terminal portion. The connection portion is located between the support surface and the body. The connection portion is connected to the body. The connection portion is disposed with a gap between it and the outer terminal portion of the fixed terminal.

[0006] In the embodiment of the electromagnetic relay, the connection portion is disposed with a gap between it and the outer terminal portion of the fixed terminal. Therefore, when torque from bolting is applied to the outer terminal portion of the fixed terminal, it is difficult for the torque to be transmitted to the connection portion. This increases the strength of the housing against torque from bolting.

[0007] The support portion may include a nut compartment recessed from the support surface. In this case, the bolt is secured to the outer terminal by a nut disposed in the nut compartment. The outer terminal may include a through-hole for a bolt to pass through.
[0008] The through-hole may face the nut compartment. In this case, a connecting member such as a bus bar is fixed to the fixed terminal by passing a bolt through a nut in the nut compartment and the through-hole in the outer terminal portion of the fixed terminal.
[0009] The support portion may further include an intermediate portion. The intermediate portion may be located between the connection portion and the support surface. The intermediate portion may extend in an inclined direction relative to the outer terminal. In this case, the strength of the support portion is improved.
[0010] The support portion may further include a recess and a rib. The recess may be recessed from the surface of the intermediate portion. The rib may be disposed in the recess. In this case, the rib increases the strength of the intermediate portion.
[0011] The body may include a slit extending from the opening. The outer terminal may extend through the slit. In this case, installation of the fixed terminal in the housing is facilitated.
[0012] The connection portion may be located away from the slit. In this case, it is difficult for the torque from bolting to be transmitted to the portion of the housing adjacent to the slit. This increases the strength of the housing against torque from bolting.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0013] FIG. **1** is a perspective view of an embodiment of an electromagnetic relay in accordance with the claimed invention.
[0014] FIG. **2** is a front view of the electromagnetic relay.
[0015] FIG. **3** is a cross-sectional view of the electromagnetic relay.
[0016] FIG. **4** is a cross-sectional view of the electromagnetic relay.
[0017] FIG. **5** is a perspective view of a case used in the electromagnetic relay shown in FIGS. **1**-**4**.
[0018] FIG. **6** is a perspective view of a top portion of the case.
[0019] FIG. **7** is a top view of the case.
[0020] FIG. **8** is an enlarged view of a first support portion.
[0021] FIG. **9** is an enlarged view of a second support portion.
DETAILED DESCRIPTION
[0022] Hereinafter, an exemplary embodiment of an electromagnetic relay in accordance with the claimed invention will be described with reference to the drawings. FIG. **1** is a perspective view of an embodiment of an electromagnetic relay **1**. FIG. **2** is a front view of the electromagnetic relay **1**. FIG. **3** is a cross-sectional view of the electromagnetic relay **1**. As shown in FIGS. **1** to **3**, the electromagnetic relay **1** includes a housing **2**, a contact device **3**, and a drive device **4**. The housing **2** houses the contact device **3**. The contact device **3** includes a first fixed terminal **6**, a second fixed terminal **7**, a movable contact piece **8**, a movable mechanism **9**, a first fixed contact **10**, a second fixed contact **11**, a first movable contact **12**, and a second movable contact **13**.
[0023] In the following description, the direction in which the fixed contact **10** and the movable contact **12** face each other is defined as the vertical direction. The direction perpendicular to the vertical direction is defined as the lateral direction. The lateral direction includes the left-right and front-back directions. The longitudinal direction of the movable contact piece **8** is defined as the left-right direction. The direction perpendicular to the vertical direction and the left-right direction is defined as the front-back direction. The direction from the movable contacts **12** and **13** to the fixed contacts **10** and **11** is defined as the contact direction (Z**1**). The direction from the fixed contacts **10** and **11** to the movable contacts **12** and **13** is defined as the separation direction (Z**2**).

[0024] The first fixed terminal **6**, the second fixed terminal **7**, the movable contact piece **8**, the first fixed contact **10**, the second fixed contact **11**, the first movable contact **12**, and the second movable contact **13** are made of conductive material. For example, the first fixed terminal **6**, the second fixed terminal **7**, and the movable contact piece **8** are made of metal materials known as terminal materials, such as copper-based metals. However, the first fixed terminal **6**, the second fixed terminal **7**, and the movable contact piece **8** may be made of different materials. The first fixed contact **10**, the second fixed contact **11**, the first movable contact **12**, and the second movable contact **13** are made of metal materials known as contact materials, such as copper-based metals or silver-based metals.

[0025] The first fixed terminal **6** and the second fixed terminal **7** are disposed apart from each other in the left-right direction. The first and second fixed terminals **6** and **7**, respectively, have a plate shape. The first fixed terminal **6** and the second fixed terminal **7** protrude from inside of the housing **2** to the outside of the housing **2**. The first fixed contact **10** is connected to the first fixed terminal **6**. The second fixed contact **11** is connected to the second fixed terminal **7**. The first fixed contact **10** and the second fixed contact **11** are disposed inside of the housing **2**.

[0026] The first fixed terminal **6** includes a first contact support portion **14** and a first outer terminal portion **15**. The first fixed contact **10** is connected to the first contact support portion **14**. The first outer terminal portion **15** includes a first through-hole **16** for a bolt. The first outer terminal portion **15** protrudes laterally from the housing **2**. The second fixed terminal **7** includes a second contact support portion **17** and a second outer terminal portion **18**. The second fixed contact **11** is connected to the second contact support portion **17**. The second outer terminal portion **18** includes a second through-hole **19** for a bolt. The second outer terminal portion **18** protrudes laterally from the housing **2**. The second outer terminal portion **18** protrudes from the housing **2** on the opposite side from the first outer terminal portion **15**.

[0027] The movable contact piece **8**, the first movable contact **12**, and the second movable contact **13** are disposed inside of the housing **2**. The first movable contact **12** and the second movable contact **13** are connected to the movable contact piece **8**. The first movable contact **12** faces the first fixed contact **10**. The second movable contact **13** faces the second fixed contact **11**. The first movable contact **12** is disposed apart from the second movable contact **13** in the left-right direction.

[0028] The movable contact piece **8** is movable in the vertical direction. The movable contact piece **8** is configured to move between an open position shown in FIG. **3** and a closed position shown in FIG. **4**. As shown in FIG. **3**, with the movable contact piece **8** in the open position, the movable contacts **12** and **13** are separated from the fixed contacts **10** and **11**. As shown in FIG. **4**, with the movable contact piece **8** in the closed position, the movable contacts **12** and **13** are in contact with the fixed contacts **10** and **11**.

[0029] The movable mechanism **9** supports the movable contact piece **8**. The movable mechanism **9** includes a drive shaft **21** and a contact spring **22**. The drive shaft **21** is connected to the movable contact piece **8**. The drive shaft **21** extends in the vertical direction and penetrates the movable contact piece **8** in the vertical direction. The drive shaft **21** is movable in the vertical direction. The contact spring **22** biases the movable contact piece **8** toward the contact direction (Z**1**).

[0030] As shown in FIGS. **3** and **4**, the drive device **4** moves the drive shaft **21** in the vertical direction. The drive device **4** includes a coil **23**, a spool **24**, a movable iron core **25**, a fixed iron core **26**, a yoke **27**, and a return spring **28**. The drive device **4** moves the movable contact piece **8** to the open and closed positions via the movable mechanism **9** by electromagnetic force. The coil **23** is wound around the spool **24**. The movable iron core **25** and the fixed iron core **26** are disposed in the spool **24**. The movable iron core **25** is connected to the drive shaft **21**. The movable iron core **25** is movable in the vertical direction. The fixed iron core **26** is disposed to face the movable iron core **25**. The return spring **28** biases the movable iron core **25** in the separation direction (Z**2**).

[0031] In the electromagnetic relay **1**, when the coil **23** is energized, the magnetic force from the coil **23** attracts the movable iron core **25** to the fixed iron core **26**. Thereby, the movable iron core

25 and the drive shaft **21** move in the contact direction (Z**1**) against the biasing force of the return spring **28**. Thereby, the movable contact piece **8** moves to the closed position shown in FIG. **4**, and the movable contacts **12** and **13** contact the fixed contacts **10** and **11**. After the movable contacts **12** and **13** contact the fixed contacts **10** and **11**, the contact spring **22** is compressed by the drive shaft **21** moving further in the contact direction (Z**1**).

[0032] When the coil **23** is de-energized, the movable iron core **25** and the drive shaft **21** move in the separation direction (Z**2**) by the biasing force of the return spring **28**. Thereby, the movable contact piece **8** moves to the open position shown in FIG. **3**, and the movable contacts **12** and **13** separate from the fixed contacts **10** and **11**.

[0033] The structure of the housing **2** is described next. As shown in FIGS. **1** and **2**, the housing **2** includes a case **31** and a cover **32**. The case **31** and the cover **32** are separate bodies from each other. FIG. **5** is a perspective view of the case **31**. As shown in FIG. **5**, the case **31** includes an opening **33**. The contact device **3** and the drive device **4** described above are disposed in the case **31** through the opening **33**. Afterward, the cover **32** is attached to the case **31** to close the opening **33**. The case **31** and the cover **32** are made of resin. The case **31** and the cover **32** are bonded together by adhesive **34**. The adhesive **34** is applied between the case **31** and the cover **32** in a liquid state and then cures to bond the case **31** and the cover **32**.

[0034] FIG. **6** is a perspective view of the top portion of the case **31**. FIG. **7** is a top view of the case **31**. As shown in FIGS. **5** to **7**, the case **31** includes a case body **35**, a first mount **36**, a second mount **37**, a first outer-terminal support portion **38**, and a second outer-terminal support portion **39**. The case body **35** houses the contact device **3** and the drive device **4**. The case body **35** includes the opening **33** described above. The opening **33** is disposed on the front surface of the case body **35**. The case body **35** includes a top surface **41**, a bottom surface **42**, a first side surface **43**, a second side surface **44**, and a rear surface **45**.

[0035] The case body **35** includes a first slit **46**, a second slit **47**, and a third slit **48**. The first slit **46**, the second slit **47**, and the third slit **48** extend from the opening **33** in the front-rear direction. The first slit **46** is disposed on the first side surface **43**. The first outer terminal portion **15** extends through the first slit **46**. The second slit **47** is disposed on the second side surface **44**. The second outer terminal portion **18** extends through the second slit **47**.

[0036] The third slit **48** is disposed on the first side surface **43**. The third slit **48** is disposed below the first slit **46**. The connector **49** shown in FIG. **1** extends through the third slit **48**. The connector **49** is connected to the coil **23**.

[0037] As shown in FIGS. **1** and **2**, the cover **32** includes a cover body **51**, a first cover portion **52**, a second cover portion **53**, and a third cover portion **54**. The cover body **51** is disposed within the opening **33**. The cover body **51** closes the opening **33**. The first cover portion **52** extends from the cover body **51**. The first cover portion **52** is disposed within the first slit **46**. The first cover portion **52** closes the first slit **46**. The second cover portion **53** extends from the cover body **51**. The second cover portion **53** is disposed within the second slit **47**. The second cover portion **53** closes the second slit **47**. The third cover portion **54** extends from the cover body **51**. The third cover portion **54** is disposed in the third slit **48**. The third cover portion **54** closes the third slit **48**.

[0038] The adhesive **34** bonds the cover body **51** to the case **31**, within the opening **33**. The adhesive **34** bonds the first cover portion **52** within the first slit **46**. The adhesive **34** bonds the second cover portion **53** within the second slit **47**. The adhesive **34** bonds the third cover portion **54** within the third slit **48**.

[0039] The first mount **36** is connected to the first side surface **43**. The first mount **36** protrudes laterally from the first side surface **43**. The first mount **36** is disposed flush with the bottom surface **42**. The first mount **36** includes a first mounting hole **55**. A bolt for fixing the electromagnetic relay **1** is passed through the first mounting hole **55**. The second mount **37** is connected to the second side surface **44**. The second mount **37** protrudes laterally from the second side surface **44**. The second mount **37** protrudes from the second side surface **44** to the opposite side of the first mount

36 in the left-right direction. The second mount **37** is disposed flush with the bottom surface **42**. The second mount **37** includes a second mounting hole **56**. A bolt for fixing the electromagnetic relay **1** is passed through the second mounting hole **56**.

[0040] The first outer-terminal support portion **38** is connected to the first side surface **43**. The first outer-terminal support portion **38** protrudes laterally from the first side surface **43**. The first outer-terminal support portion **38** is disposed below the first outer terminal portion **15**. The first outer-terminal support portion **38** supports the first outer terminal portion **15**. The second outer-terminal support portion **39** is connected to the second side surface **44**. The second outer-terminal support portion **39** protrudes laterally from the second side surface **44**. The second outer-terminal support portion **39** protrudes from the second side surface **44** to the opposite side of the first outer-terminal support portion **38** in the left-right direction. The second outer-terminal support portion **39** is disposed below the second outer terminal portion **18**. The second outer-terminal support portion **39** supports the second outer terminal portion **18**. The first outer-terminal support portion **38** and the second outer-terminal support portion **39** are integrally formed with the case body **35**.

[0041] FIG. **8** is an enlarged view of the first outer-terminal support portion **38**. As shown in FIG. **8**, the first outer-terminal support portion **38** includes a first flat portion **61**, a first connection portion **62**, and a first intermediate portion **63**. The first flat portion **61** extends in the left-right direction. The first flat portion **61** includes a first support surface **64**. The first support surface **64** has a flat shape. The first support surface **64** is in contact with the first outer terminal portion **15** and supports the first outer terminal portion **15**.

[0042] The first connection portion **62** is disposed between the first support surface **64** and the first side surface **43**. The first connection portion **62** is connected to the first side surface **43**. The first connection portion **62** is disposed below the first support surface **64**. The first connection portion **62** is disposed downward and away from the first outer terminal portion **15**. The first connection portion **62** is disposed with a gap G**1** with respect to the first outer terminal portion **15**. The first connection portion **62** is disposed downward and away from the first slit **46**.

[0043] The first intermediate portion **63** is disposed between the first flat portion **61** and the first connection portion **62**. The first intermediate portion **63** is connected to the first flat portion **61** and the first connection portion **62**. The first intermediate portion **63** extends in a direction inclined to the first outer terminal portion **15**. The first intermediate portion **63** extends diagonally upward from the first connection portion **62** toward the first flat portion **61**. The first intermediate portion **63** is also disposed with the gap G**1** with respect to the first outer terminal portion **15**.

[0044] As shown in FIGS. **6** and **7**, the first outer-terminal support portion **38** includes a first nut compartment **65**. The first nut compartment **65** is recessed from the first support surface **64**. The first nut compartment **65** faces the first through-hole **16**. As shown in FIG. **3**, a first nut **66** is disposed in the first nut compartment **65**. The first nut **66** may be disposed in the first nut compartment **65** by insert molding. The first nut **66** faces the first through-hole **16** of the first fixed terminal **6**. A connecting member, such as a bus bar, is secured to the first fixed terminal **6** by a bolt that is passed through the first nut **66** and the first through-hole **16**.

[0045] The first outer-terminal support portion **38** includes a first recess **67** and a first rib **68**. The first recess **67** is recessed from the top surface of the first intermediate portion **63**. The first rib **68** is disposed in the first recess **67**. The first rib **68** extends in the left-right direction within the first recess **67**. The first rib **68** increases the strength of the first intermediate portion **63**.

[0046] FIG. **9** is an enlarged view of the second outer-terminal support portion **39**. As shown in FIG. **9**, the second outer-terminal support portion **39** includes a second flat portion **71**, a second connection portion **72**, and a second intermediate portion **73**. The second outer-terminal support portion **39** has a structure symmetrical to the first outer-terminal support portion **38**. The second flat portion **71**, the second connection portion **72**, and the second intermediate portion **73** have the same structure as the first flat portion **61**, the first connection portion **62**, and the first intermediate portion **63**, respectively. The second connection portion **72** is disposed with a gap G**2** with respect

to the second outer terminal portion **18** in the same manner as the first connection portion **62** is disposed with the gap G**1** with respect to the first outer terminal portion **15**.
[0047] The second flat portion **71** includes a second support surface **74** and a second nut compartment **75**. The second support surface **74** and the second nut compartment **75** have the same structure as the first support surface **64** and the first nut compartment **65**, respectively. A second nut **76** is disposed in the second nut compartment **75**. The second outer-terminal support portion **39** includes a second recess **77** and a second rib **78**. The second recess **77** and the second rib **78** have the same structure as the first recess **67** and the first rib **68**, respectively.
[0048] In the above-described electromagnetic relay **1**, in the first outer-terminal support portion **38**, the first connection portion **62** is disposed with the gap G**1** with respect to the first outer terminal portion **15**. Therefore, when torque from bolting is applied to the first outer terminal portion **15**, it is difficult for the torque to be transmitted to the first connection portion **62**. In the second outer-terminal support portion **39**, the second connection portion **72** is disposed with the gap G**2** with respect to the second outer terminal portion **18**. Therefore, when torque from bolting is applied to the second outer terminal portion **18**, it is difficult for the torque to be transmitted to the second connection portion **72**. This increases the strength of the housing **2** against torque caused by bolting.
[0049] Although one embodiment of the claimed invention has been described above, the invention is not limited to the above embodiment, and various changes can be made without departing from the scope of the claimed invention.
[0050] The structure of the drive device **4** is not limited to that of the above embodiment, but may be modified. For example, the separation direction (Z**2**) and the contact direction (Z**1**) may be opposite to the above embodiment. The first fixed terminal **6** and the second fixed terminal **7** may protrude from the housing **2** not only in the left-right direction but also in the front-back direction.
[0051] The structure of the contact device **3** is not limited to that of the above embodiment, but may be modified. For example, the first fixed contact **10** may be a separate body from the first fixed terminal **6**, or integral with the first fixed terminal **6**. The second fixed contact **11** may be a separate body from the second fixed terminal **7**, or integral with the second fixed terminal **7**. The first movable contact **12** may be a separate body from the movable contact piece **8**, or may be integral with the movable contact piece **8**. The second movable contact **13** may be a separate body from the movable contact piece **8**, or may be integral with the movable contact piece **8**.
REFERENCE SIGNS LIST
[0052] **2**: Housing, **6**: First fixed terminal, **8**: Movable contact piece, **10**: First fixed contact, **12**: First movable contact, **14**: First contact support, **15**: First outer terminal, **16**: First through-hole, **32**: Cover, **33**: Opening, **34**: Adhesive, **35**: Case body, **38**: First support portion, **46**: First slit, **62**: First connection portion, **63**: First intermediate portion, **64**: First support surface, **65**: First nut compartment, **67**: First recess, **68**: First rib

Claims

1. An electromagnetic relay, comprising: a fixed contact; a fixed terminal including an outer terminal portion and a contact support portion connected to the fixed contact, the fixed terminal having a plate shape; a movable contact facing the fixed contact; a movable contact piece connected to the movable contact; and a housing including a body housing the contact support, the fixed contact, the movable contact, and the movable contact piece, the body having an opening, a cover attached to the body, the cover closing the opening, an adhesive bonding the body and the cover, and a support portion protruding laterally from the body, the support portion being disposed below the outer terminal portion of the fixed terminal protruding laterally from the body to support the outer terminal portion of the fixed terminal, the support portion including a support surface in contact with the outer terminal portion of the fixed terminal, and a connection portion disposed

between the support surface and the body, the connection portion being connected to the body, the connection portion being disposed with a gap between it and the outer terminal portion of the fixed terminal.

2. The electromagnetic relay according to claim 1, wherein the support portion includes a nut compartment recessed from the support surface.

3. The electromagnetic relay according to claim 2, wherein the outer terminal portion of the fixed terminal includes a through-hole for a bolt, the through-hole facing the nut compartment.

4. The electromagnetic relay according to claim 1, wherein the support portion further includes an intermediate portion disposed between the connection portion and the support surface, and the intermediate portion extends in a direction inclined to the outer terminal portion of the fixed terminal.

5. The electromagnetic relay according to claim 4, wherein the support portion includes a recess recessed from a surface of the intermediate portion, and a rib disposed in the recess.

6. The electromagnetic relay according to claim 1, wherein the body includes a slit extending from the opening, and the outer terminal extends through the slit.

7. The electromagnetic relay according to claim 1, wherein the connection portion is spaced away from the slit.