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Electric valve

Abstract

An electric valve includes a motor, a power transmission mechanism that converts rotational movement generated by the motor into axial movement of a valve body, a housing that accommodates at least a part of the power transmission mechanism and the motor, an external connector that is provided to the housing and enables power supply to the motor and communication with a control device connected via a network, and a control substrate that is provided in the housing, processes the communication and controls the motor, and has a connection position connected to an external connector-side terminal and a connection position connected to a motor-side terminal disposed on opposite sides to each other with respect to the axis of the motor.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATION

(1) This Application is a 371 of PCT/JP2022/013209 filed on Mar. 22, 2022, which claimed priority of Japanese Application No. 2021-077657 filed on Apr. 30, 2021, both of which are incorporated herein by reference.

TECHNICAL FIELD

(2) The present disclosure relates to an electric valve.

BACKGROUND ART

(3) WO 2020/203007 A discloses an electric valve which includes a motor including a stator member and a rotor member that displace a valve body, and a housing that accommodates the motor. The cover member of the housing holds a control substrate including a drive circuit that drives the motor. The tube-shaped member of the housing is provided with a connector portion (external connector) connectable to an external power source. The terminal disposed inside the connector portion is connected to the control substrate via the flexible board.

SUMMARY OF INVENTION

Technical Problem

(4) As an example of a communication standard for reducing the cost of an in-vehicle network, Local Interconnect Network (LIN) has been developed. An electric valve used in an in-vehicle air conditioner is also equipped with a LIN communication function. Such an electric valve has a control substrate for processing LIN communication, and shares a power supply line, a ground line, and a communication line via a connector. In the electric valve, LIN communication is processed by a microcomputer such as an IC mounted on a control substrate to control energization of a motor inside the electric valve, whereby opening and closing of the valve are controlled.

(5) In the conventional example described above, since the control substrate for LIN communication is not provided, the control substrate is installed near the external connector, and the external connector and the motor connector connecting the motor to the control substrate are disposed close to each other.

(6) However, in a current electric valve having a LIN communication function, since a new motor connector (flexible board) is installed in the control substrate in the vicinity of the external connector, the IC or the like cannot be installed in the vicinity of the connector portion, and the IC or the like is installed at a position on the radially opposite side of the electric valve away from the external connector.

(7) As a result, a signal (current) input from the external connector is processed by an IC or the like away from the external connector through, for example, the upper surface of the control substrate, then returns to the external connector side through, for example, the lower surface of the control substrate, and is provided to the motor via the flexible board. However, the presence of such a complicated electric path in the control substrate is a cause for receiving and transmitting noise. In addition, since the flexible board has flexibility, it is difficult to stabilize the electric path.

(8) It is an object of the disclosure to improve noise performance in an electric valve having a communication function.

Solution to Problem

(9) An electric valve according to a first mode includes: a motor: a power transmission mechanism that converts rotational movement generated by the motor into axial movement of a valve body: a housing that accommodates at least a part of the power transmission mechanism and the motor: an external connector that is provided to the housing and enables power supply to the motor and communication with a control device connected via a network: and a control substrate that is provided in the housing, processes the communication, and controls the motor, in which a

connection position connected to an external connector-side terminal and a connection position connected to a motor-side terminal in the control substrate are each located on each of both end sides in a longitudinal direction of the control substrate.

(10) The electric valve has a function of communication with a control device connected by a network, and a control substrate processes communication and controls a motor. In this control substrate, since the connection position connected to the external connector-side terminal and the connection position connected to the motor-side terminal are each located on each of both end sides in the longitudinal direction of the control substrate, the electric path from the external connector to the motor via the control substrate is simplified to one direction.

(11) According to a second mode, in the electric valve according to the first mode, the control substrate includes a first substrate portion disposed in a direction intersecting an axis of the motor and connected to the external connector-side terminal, and a second substrate portion disposed in a direction along the axis of the motor and connected to the motor-side terminal, and the first substrate portion and the second substrate portion are coupled by a flex wiring portion that is thinner and more flexible than the first substrate portion and the second substrate portion.

(12) In the electric valve, the control substrate includes a first substrate portion connected to the external connector-side terminal and a second substrate portion connected to the motor-side terminal, and the first substrate portion and the second substrate portion are coupled by a flex wiring portion. The flex wiring portion is thinner and more flexible than the first substrate portion and the second substrate portion. In other words, the first substrate portion and the second substrate portion are thicker and less flexible than the flex wiring portion. As compared with a case in which a member having flexibility as a whole such as a flexible board is connected to the motor-side terminal, the second substrate portion having relatively low flexibility is connected to the motor-side terminal, whereby reception and transmission of noise from the second substrate portion is suppressed.

(13) Further, after the second substrate portion is connected to the motor-side terminal while being disposed in the direction along the axis of the motor, the flex wiring portion is bent to connect the first substrate portion to the external connector-side terminal, whereby the first substrate portion can be easily disposed in a direction intersecting the axis of the motor.

(14) According to a third mode, in the electric valve according to the second mode, the external connector-side terminal and the motor-side terminal are press-fit terminals that are each press-fitted into each through hole provided in the control substrate.

(15) In this electric valve, since the external connector-side terminal and the motor-side terminal are press-fit terminals and are each press-fitted into each through hole of the control substrate, the control substrate can be easily installed. In addition, since soldering is unnecessary, there is no concern about solder cracks and globules of solder, and improvement in reliability is expected. Further, at the same time as the process of bending the control substrate at the flex wiring portion, the first substrate portion can be connected to the external connector-side terminal.

(16) According to a fourth mode, in the electric valve according to the second mode or the third mode, a gap that enables the first substrate portion to be gripped during assembly is provided between the first substrate portion and the housing.

(17) In this electric valve, since a gap is provided between the first substrate portion and the housing, a process of gripping the first substrate portion by a tool (for example, a hand of an assembly robot) and connecting the first substrate portion to the external connector-side terminal can be easily performed.

Advantageous Effects of Invention

(18) According to the disclosure, noise performance can be improved in an electric valve having a communication function.

Description

BRIEF DESCRIPTION OF DRAWINGS

(1) FIG. **1** is a cross-sectional view illustrating an electric valve according to the present embodiment.

(2) FIG. **2** is a plan view illustrating a state in which a cover member of a housing is removed to expose a control substrate in the electric valve according to the present embodiment.

(3) FIG. **3** is a cross-sectional view illustrating a process of installing a control substrate in the electric valve according to the present embodiment.

(4) FIG. **4** is a plan view illustrating a state in which a cover member of a housing is removed to expose a control substrate in an electric valve according to a modification.

DESCRIPTION OF EMBODIMENTS

(5) Hereinafter, embodiments for carrying out the disclosure will be described with reference to the drawings. In the drawings, components denoted by the same reference numerals mean the same or similar components. Note that overlapping descriptions and reference numerals in the embodiments described below may be omitted. In addition, the drawings used in the following description are all schematic, and dimensional relationships of respective components, ratios of respective components, and the like illustrated in the drawings do not necessarily coincide with actual ones. In addition, dimensional relationships of the respective elements, ratios of the respective elements, and the like do not necessarily coincide among a plurality of drawings.

(6) In FIGS. **1** and **2**, an electric valve **10** according to the present embodiment includes a motor **12**, a power transmission mechanism **14**, a housing **16**, an external connector **18**, and a control substrate **20**. In FIG. **1**, the axial direction of the power transmission mechanism **14** (axial direction of the motor) is defined as a vertical direction, and a lid body **24** of the housing **16** described later is located on the upper side. For convenience, the positional relationship of each member will be described with reference to this arrangement.

(7) The motor **12** is, for example, a stepping motor. The power supply portion **12**A of the motor **12** is provided with motor-side terminals **12**B at, for example, four locations. The motor-side terminal **12**B is, for example, a press-fit terminal, and is press-fitted into a through hole **32** provided in the control substrate **20**. Since the structure of the motor **12** is known, other description will be omitted.

(8) The power transmission mechanism **14** is a mechanism that converts rotational movement generated by the motor **12** into axial movement of a valve body (not illustrated). Since the structure of the power transmission mechanism **14** is known, other description will be omitted. Note that reference numeral **14** indicates a can that accommodates at least a part of the power transmission mechanism, and the can is not included in the power transmission mechanism **14**.

(9) The housing **16** is a member that houses at least a part of the power transmission mechanism **14** and the motor **12**, and includes, for example, a cylindrical portion **22** and a lid body **24** for closing an upper end of the cylindrical portion **22**. The housing **16** also houses a control substrate **20** and the like in addition to the motor **12** and the power transmission mechanism **14**. For example, an O-ring **26** is disposed in a portion of the housing **16** in contact with the power transmission mechanism **14**.

(10) The power transmission mechanism **14** is provided with a mounting bracket **28** adjacent to the lower side of the housing **16**. A lower base member having a flow path opened and closed by the electric valve **10** can be attached to a further lower side of the mounting bracket **28**. The valve body driven by the electric valve **10** is disposed in the lower base member.

(11) The external connector **18** is provided to the housing **16** and enables power supply to the motor **12** and communication, for example, LIN communication, with the control device **50** connected via a network **48**. LIN is an example of an in-vehicle network. The external connector **18**

is connected to the control device **50** via the network **48**, and power is supplied to the control substrate **20** via the external connector **18**. In FIG. **1**, the external connector **18** extends horizontally from the housing **16**. A terminal **18**A disposed inside the external connector **18** is electrically connected to an external connector-side terminal **18**B extending upward inside the housing **16**. The external connector-side terminal **18**B is, for example, a press-fit terminal, is provided at, for example, four locations, and press-fitted into a through hole **38** provided in the control substrate **20**.

(12) The control substrate **20** is provided in the housing **16**, and is mounted with a microcomputer (electronic component **34** such as an IC) that processes communication, for example, LIN communication, with the control device **50**, and controls the motor **12**. In the control substrate **20**, the connection position (through hole **38**) connected to the external connector-side terminal **18**B and the connection position (through hole **32**) connected to the motor-side terminal **12**B are each located on each of both end sides in the longitudinal direction of the control substrate **20**. As an example, the connection position connected to the external connector-side terminal **18**B and the connection position connected to the motor-side terminal **12**B are disposed on opposite sides to each other with respect to the axis L of the motor **12**. In the illustrated example, the connection position for connection of the control substrate **20** and the external connector-side terminal **18**B is disposed on the right side of the axis L of the motor **12**, and the connection position for connection of the control substrate **20** and the motor-side terminal **12**B is disposed on the left side of the axis L of the motor **12**.

(13) The control substrate **20** includes a first substrate portion **41**, a second substrate portion **42**, and a flex wiring portion **43**. The first substrate portion **41** is disposed in a direction intersecting the axis L of the motor **12** and is connected to the external connector-side terminal **18**B. The second substrate portion **42** is disposed in the direction along the axis L of the motor **12** and is connected to the motor-side terminal **12**B. The flex wiring portion **43** is obtained by, for example, processing a part of the control substrate **20** to be thinner than the first substrate portion **41** and the second substrate portion **42**, and has flexibility. The first substrate portion **41** and the second substrate portion **42** are coupled and integrated by a flex wiring portion **43**. As illustrated in FIG. **3**, the control substrate **20** before installation has a substantially flat plate shape as a whole because the flex wiring portion **43** has not been bent yet.

(14) As illustrated in FIG. **2**, positioning holes **41**A are formed at, for example, four locations of the first substrate portion **41**. The housing **16** is provided with bosses **30** at four locations for positioning, and the first substrate portion **41** is positioned and held by inserting the bosses **30** into the positioning holes **41**A. By deforming the boss **30**, the first substrate portion **41** may be prevented from being detached from the boss **30**.

(15) Between the first substrate portion **41** and the housing **16**, a gap S that enables the first substrate portion **41** to be gripped at the time of assembly is provided. The gap S serves as a margin for gripping by a tool (not illustrated). The tool is, for example, a hand of an assembly robot. When the width W of the first substrate portion **41** is narrowed in order to provide the gap S, the mounting area of the electronic components is reduced. However, since the electronic components can also be mounted on the second substrate portion **42**, the mounting area of the electronic components is sufficiently secured.

(16) As illustrated in FIG. **3**, when the control substrate **20** is installed to the electric valve **10**, the entire control substrate **20** is erected in the vertical direction, and the motor-side terminal **12**B is press-fitted into the through hole **32** of the second substrate portion **42**. Next, the first substrate portion **41** is folded in the direction of the arrow A, and the external connector-side terminal **18**B is press-fitted into the through hole **38** of the first substrate portion **41**. At this time, the flex wiring portion **43** is bent. The boss **30** is inserted into the positioning hole **41**A (FIG. **2**). Then, the lid body **24** is attached to the cylindrical portion **22** (direction of arrow B) to close the upper end of the cylindrical portion **22**.

(17) (Operation)

(18) The present embodiment is configured as described above, and the operation thereof will be described below: In FIG. **1**, the electric valve **10** according to the present embodiment has a LIN communication function, and the control substrate **20** processes the LIN communication and controls the motor **12**. In the control substrate **20**, since the connection position (through hole **38**) connected to the external connector-side terminal **18**B and the connection position (through hole **32**) connected to the motor-side terminal **12**B are disposed on opposite sides to each other with respect to the axis L of the motor **12**, the electric path from the external connector **18** to the motor **12** via the control substrate **20** is simplified to one direction (arrow C direction).
(19) In the electric valve **10**, the control substrate **20** includes a first substrate portion **41** connected to the external connector-side terminal **18**B and a second substrate portion **42** connected to the motor-side terminal **12**B, and the first substrate portion **41** and the second substrate portion **42** are coupled by a flex wiring portion **43**. The flex wiring portion **43** is thinner and more flexible than the first substrate portion **41** and the second substrate portion **42**. In other words, the first substrate portion **41** and the second substrate portion **42** are thicker and less flexible than the flex wiring portion **43**. As compared with a case in which a member having flexibility as a whole such as a flexible board is connected to the motor-side terminal **12**B, the second substrate portion **42** having relatively low flexibility is connected to the motor-side terminal **12**B, whereby reception and transmission of noise from the second substrate portion **42** is suppressed.
(20) Further, after the second substrate portion **42** is connected to the motor-side terminal **12**B while being disposed in the direction along the axis L of the motor **12**, the flex wiring portion **43** is bent to connect the first substrate portion **41** to the external connector-side terminal **18**B, whereby the first substrate portion **41** can be easily disposed in a direction intersecting the axis L of the motor **12**.
(21) In this electric valve **10**, since the external connector-side terminal **18**B and the motor-side terminal **12**B are press-fit terminals and are press-fitted into the through holes **38** and **32** of the control substrate **20**, respectively, the control substrate **20** can be easily installed. In addition, since soldering is unnecessary, there is no concern about solder cracks and globules of solder, and improvement in reliability is expected. Further, at the same time as the process of bending the control substrate **20** at the flex wiring portion **43**, the first substrate portion **41** can be connected to the external connector-side terminal **18**B.
(22) As illustrated in FIG. **2**, since the gap S is provided between the first substrate portion **41** and the housing **16**, a process of gripping the first substrate portion by a tool (for example, a hand of an assembly robot) and connecting the first substrate portion **41** to the external connector-side terminal **18**B can be easily performed.
(23) As described above, according to the present embodiment, the noise performance can be improved in the electric valve **10** having a communication function.
OTHER EMBODIMENTS
(24) Although an example of the embodiment of the disclosure has been described above, the embodiment of the disclosure is not limited to the above, and it is a matter of course that various modifications can be made without departing from the gist of the present disclosure in addition to the above.
(25) In the embodiment, the control substrate **20** includes the first substrate portion **41**, the second substrate portion **42**, and the flex wiring portion **43**, but the configuration of the control substrate **20** is not limited thereto. Any suitable configuration may be used as long as in the control substrate **20**, the connection position connected to the external connector-side terminal **18**B and the connection position connected to the motor-side terminal **12**B are disposed on opposite sides with respect to the axis L of the motor **12**. Although LIN has been described as an example of the in-vehicle network, the in-vehicle network is not limited thereto, and may be CAN or the like.
(26) As in the modification illustrated in FIG. **4**, in the control substrate **20**, the connection position connected to the external connector-side terminal **18**B and the connection position connected to the

motor-side terminal **12**B may be disposed on sides different from each other by 90° with respect to the axis L of the motor **12**. That is, both the connection positions may be disposed at any suitable locations as long as both the connection positions are not disposed on the same side with respect to the axis L of the motor **12**.
(27) Although press-fit terminals are used as the external connector-side terminal **18**B and the motor-side terminal **12**B, a configuration in which connection is carried out by soldering without using a press-fit terminal is acceptable.
(28) Although the gap S serving as a margin for gripping by a tool is provided between the first substrate portion **41** and the housing **16**, the gap S is not necessarily provided.
(29) The entire disclosure of Japanese Patent Application No. 2021-77657 filed on Apr. 30, 2021 is incorporated herein by reference.
(30) All the documents, patent applications, and technical standards cited in this specification are incorporated herein by reference to the same extent as when each individual document, patent application, or technical standard is specifically and individually indicated to be incorporated by reference.

Claims

1. An electric valve comprising: a motor; a power transmission mechanism that converts rotational movement generated by the motor into axial movement of a valve body; a housing that accommodates at least a part of the power transmission mechanism and the motor; an external connector that is provided at the housing and enables power supply to the motor and communication with a control device connected via a network; and a control substrate that is provided in the housing, processes the communication, and controls the motor, wherein a connection position at which the control substrate is connected to an external connector-side terminal and a connection position at which the control substrate is connected to a motor-side terminal are respectively located on both end sides in a longitudinal direction of the control substrate, the control substrate includes a first substrate portion disposed in a direction intersecting an axis of the motor and connected to the external connector-side terminal, a second substrate portion disposed in a direction along the axis of the motor and connected to the motor-side terminal, and a flex wiring portion that couples the first substrate portion and the second substrate portion, the flex wiring portion being thinner and more flexible than the first substrate portion and the second substrate portion, and the control substrate including the first substrate, the second substrate, and the flex wiring portion is formed as a substantially flat plate, the flex wiring portion being bent during installation so that the first substrate portion is disposed in the direction intersecting an axis of the motor and the second substrate portion is disposed in the direction along the axis of the motor.
2. The electric valve according to claim 1, wherein the external connector-side terminal and the motor-side terminal are press-fit terminals that are respectively press-fitted into through holes provided at the control substrate.
3. The electric valve according to claim 1, wherein a gap that enables the first substrate portion to be gripped during assembly is provided between the first substrate portion and the housing.
4. The electric valve according to claim 2, wherein a gap that enables the first substrate portion to be gripped during assembly is provided between the first substrate portion and the housing.
5. The electric valve according to claim 1, wherein the flex wiring portion is obtained by processing a part of the control substrate to be thinner than the first substrate portion and the second substrate portion.