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# Reaction force applying device


## Abstract

A reaction force applying device includes an actuator housing, an actuator, a lever, a connected part, and a connecting part. The actuator housing is attachable to a vehicle. The actuator is provided in the actuator housing. The lever is provided in the actuator housing to be rotatable by receiving a driving force from the actuator, to contact an arm that rotates with a pedal, and to be capable of applying a reaction force to the pedal against a driver's stepping force. The connected part is provided in a pedal housing, and the connecting part is provided in the actuator housing and connected to the connected part.



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## References Cited


**U.S. PATENT DOCUMENTS**

| Patent No. | Issued Date | Patentee Name | U.S. Cl. | CPC |
|---|---|---|---|---|
| 8521360 | 12/2012 | Yamazaki | 701/36 | G05G 1/30 |
| 9079492 | 12/2014 | Osawa | N/A | B60K 26/021 |
| 9475386 | 12/2015 | Horiuchi | N/A | B60K 26/02 |
| 10124673 | 12/2017 | Kouzuma | N/A | G05G 5/03 |
| 10146247 | 12/2017 | Ooba | N/A | B60K 26/021 |
| 12084022 | 12/2023 | Yanagida | N/A | B60T 11/18 |
| 2010/0083789 | 12/2009 | Kawade | N/A | N/A |
| 2012/0096976 | 12/2011 | Leone | 74/513 | G05G 1/30 |
| 2015/0360563 | 12/2014 | Horiuchi et al. | N/A | N/A |
| 2018/0001763 | 12/2017 | Kouzuma | N/A | G05G 1/44 |
| 2019/0081419 | 12/2018 | Hsieh | N/A | N/A |
| 2021/0078549 | 12/2020 | Tsuguma | N/A | N/A |
| 2024/0100945 | 12/2023 | Mori | N/A | B60K 26/02 |

**FOREIGN PATENT DOCUMENTS**

| Patent No. | Application Date | Country | CPC |
|---|---|---|---|
| 2001310648 | 12/2000 | JP | N/A |
| 2012-82725 | 12/2011 | JP | N/A |
| WO-2012029503 | 12/2011 | WO | B60K 26/021 |
| WO-2023068336 | 12/2022 | WO | N/A |
| WO-2024070627 | 12/2023 | WO | N/A |
| WO-2024070631 | 12/2023 | WO | N/A |
| WO-2024070632 | 12/2023 | WO | N/A |


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## Background/Summary

CROSS REFERENCE TO RELATED APPLICATION (1) The present application is a continuation application of International Patent Application No. PCT/JP2022/039168 filed on Oct. 20, 2022, which designated the U.S. and claims the benefit of priority from Japanese Patent Application No. 2021-172599 filed on Oct. 21, 2021. The entire disclosures of all of the above applications are incorporated herein by reference.

TECHNICAL FIELD
(1) The present disclosure relates to a reaction force applying device.
BACKGROUND
(2) Conventionally, there has been known a reaction force applying device that is capable to apply a reaction force against a driver's stepping force to a pedal of an accelerator device that includes a pedal to be stepped by a driver.
SUMMARY
(3) The present disclosure relates to a reaction force applying device configured to apply, against a stepping force of a driver, a reaction force to a pedal of an accelerator device that includes: the pedal to be stepped by the driver; and a pedal housing provided to rotatably support the pedal and to be attached to a vehicle. The reaction force applying device includes an actuator housing, an actuator, a lever, a connected part, and a connecting part.
(4) The actuator housing is attachable to the vehicle, and the actuator is provided in the actuator housing. The lever is provided at the actuator housing to be rotatable by receiving a driving force from the actuator, to contact the pedal or an arm rotating with the pedal, and to apply a reaction force to the pedal with respect to the stepping force of the driver. The connected part may be provided in the pedal housing, and the connecting part may be provided in the actuator housing and connected to the connected part.

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## Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The above and other objects, features and advantages of the present disclosure will become more apparent from the following detailed description made with reference to the accompanying drawings. In the drawings:
(2) FIG. **1** is a diagram showing a reaction force applying device according to a first embodiment and an accelerator device to which the same is applied;
(3) FIG. **2** is a diagram when being viewed in a direction of an arrow II of FIG. **1**;
(4) FIG. **3** is a schematic diagram showing a connecting part and a connected part of the reaction force applying device of the first embodiment;
(5) FIG. **4** is a cross-sectional view taken along a line IV-IV of FIG. **3**;
(6) FIG. **5** is a schematic diagram showing a part of the reaction force applying device of the first embodiment;
(7) FIG. **6** is a schematic diagram showing a connecting part and a connected part of a reaction force applying device according to a second embodiment;
(8) FIG. **7** is a cross sectional view taken along a line VII-VII of FIG. **6**;
(9) FIG. **8** is a schematic diagram showing a connecting part and a connected part of a reaction force applying device according to a third embodiment; and
(10) FIG. **9** is a cross-sectional view taken along a line IX-IX in FIG. **8**.
DETAILED DESCRIPTION
(11) A reaction force applying device may be applied to an accelerator device that includes a pedal to be stepped by a driver. The reaction force applying device includes a lever that is in contact with an arm rotating together with a pedal of an accelerator device and can apply a reaction force to the

pedal against a driver's stepping force.
(12) For example, the reaction force applying device is attached to a vehicle at a position away from the accelerator device by a predetermined distance. That is, the reaction force applying device and the accelerator device are respectively attached to different positions on a floor of the vehicle. In this case, there is a possibility that a deviation of a contact point between the lever of the reaction force applying device and the arm of the accelerator device becomes large. As a result, a deviation amount of the reaction force with respect to a target reaction force increases, which may lead to a feeling reduce of driver notifications (notification for the driver) using a reaction force, such as dangerousness notification, fuel efficiency improvement notification and the like.
(13) It is an object of the present disclosure to provide a reaction force applying device that is capable of suppressing an increase in a deviation amount of reaction force with respect to a target reaction force.
(14) According to an exemplar of the present application, a reaction force applying device may be configured to apply, against a stepping force of a driver, a reaction force to a pedal of an accelerator device that includes: the pedal to be stepped by the driver; and a pedal housing provided to rotatably support the pedal and to be attached to a vehicle. The reaction force applying device includes an actuator housing, an actuator, a lever, a connected part, and a connecting part. Here, “attached (attachable) to a vehicle” means not only a case where it can be attached directly to a vehicle, but also a case where it can be attached indirectly to a vehicle via another member. The same applies hereinafter.
(15) The actuator housing is attachable to the vehicle, and the actuator is provided in the actuator housing. The lever is provided at the actuator housing to be rotatable by receiving a driving force from the actuator, to contact the pedal or an arm rotating with the pedal, and to apply a reaction force to the pedal with respect to the stepping force of the driver. Furthermore, the connected part is provided in the pedal housing, and the connecting part is provided in the actuator housing and connected to the connected part.
(16) In the above exemplar, the connected part provided in the pedal housing of the accelerator device and the connecting part provided in the actuator housing of the reaction force applying device are connected. Therefore, it is possible to reduce variation of a relative position between the pedal housing and the actuator housing during attachment of the device to a vehicle. Thus, it is possible to reduce the deviation of the contact point between the lever of the reaction force applying device and the pedal or arm of the accelerator device. As a result, a deviation amount of reaction force with respect to the target reaction force can be reduced. Thus, it is possible to prevent deteriorated feeling of driver notification (notification for a driver) using the reaction force.
(17) Hereinafter, a reaction force applying device according to a plurality of embodiments and an accelerator device to which the same is applied will be described based on the drawings. Elements that are substantially the same in the embodiments are denoted by the same reference signs and will not be described.
First Embodiment
(18) A reaction force applying device according to a first embodiment and an accelerator device to which the reaction force applying device is applied are shown in FIGS. **1** and **2**.
(19) An accelerator device **100** is mounted on a vehicle **1**, and is used to control a travel state of the vehicle **1** by detecting an accelerator opening degree corresponding to a rotation angle of a pedal **120** stepped on by a driver. The accelerator device **100** employs an accelerator-by-wire system, and is not mechanically connected to a throttle device of the vehicle **1**. The accelerator device **100** transmits information of the accelerator opening degree corresponding to the rotation angle of the pedal **120** to an electronic control unit (hereinafter referred to as “ECU”), which is not shown. The ECU controls the throttle device based on the accelerator opening degree transmitted from the accelerator device **100**. Thereby, a travel state of the vehicle **1** is controlled.
(20) A reaction force applying device **10** is mounted on the vehicle **1** together with the accelerator

device **100**, and can apply a reaction force F**2** to the pedal **120** of the accelerator device **100** against a driver's stepping force F**1**. By applying a reaction force to the pedal **120** of the accelerator device **100**, the reaction force applying device **10** can provide a driver notification (notification for the driver) such as dangerousness notification or fuel efficiency improvement notification. Further, the reaction force applying device **10** can serve the pedal **120** as a footrest by regulating the rotation of the pedal **120**.

(21) The accelerator device **100** includes a pedal housing **110**, the pedal **120**, and the like. The pedal housing **110** has a housing body **111** and a housing attachment portion **112**. The housing body **111** has a space which is capable of accommodating components therein. The housing attachment portion **112** is formed integrally with the housing body **111** in a form protruding from the housing body **111**. In the present embodiment, for example, three housing attachment portions **112** are formed (see FIG. **2**). A bolt hole **113** is formed in the housing attachment portion **112**. The pedal housing **110** is attached to a floor panel **2** by, for example, passing an attachment bolt **3** through the bolt hole **113**, screwing the bolt **3** into the floor panel **2** of the vehicle **1**, and fixing the housing attachment portion **112** to the floor panel **2**.

(22) In FIG. **1**, an x-axis indicates a travel direction of the vehicle **1**, a y-axis indicates a width direction of the vehicle, and a z-axis indicates a vertically upward direction. Hereinafter, unless otherwise specified, the shape or configuration of the accelerator device **100** and the reaction force applying device **10** in an attached state where they are attached to the vehicle **1** will be described. For example, the term “upward” or “upper side” means the upward or upper side of the accelerator device **100** or the reaction force applying device **10** in the attached state where it is attached to the vehicle **1**. Furthermore, in the present embodiment, the floor panel **2** has a wall surface **7** parallel to a yz plane.

(23) One end of the pedal **120** is rotatably supported by the housing body **111** of the pedal housing **110** for rotation about a rotation axis Ax**1**. An other end of the pedal **120** is provided with a pad **121** that is stepped on by the driver. Inside the housing body **111**, an accelerator opening degree sensor (not shown) is provided on the rotation axis Ax**1**. The accelerator opening degree sensor detects an accelerator opening degree corresponding to the rotation angle of the pedal **120** rotated by the driver's stepping operation, and transmits a detected accelerator opening degree to the ECU. Note that the rotation axis Ax**1** is set to be perpendicular to the z-axis and the x-axis, and parallel with the y-axis.

(24) A pedal biasing member (not shown) is provided inside the housing body **111** of the pedal housing **110**. The pedal biasing member biases the pedal **120** in an accelerator closing direction. The pedal housing **110** includes (i) a stopper that restricts rotation of the pedal **120** in the accelerator closing direction and (ii) a stopper that restricts rotation of the pedal **120** in an accelerator opening direction. The pedal **120** is allowed to rotate, within a range which is defined as the pedal **120** abuts to those stoppers. FIG. **1** shows a state in which the pedal **120** is in abutment with a stopper in the accelerator closing direction, that is, a state in which the accelerator is fully closed.

(25) As shown in FIGS. **1** and **2**, the reaction force applying device **10** includes an actuator housing **20**, an actuator **30**, a lever **40**, a connected part **61**, and a connecting part **71**.

(26) The actuator housing **20** is attachable to the vehicle **1**. The actuator **30** is provided in the actuator housing **20**. The lever **40** is provided in the actuator housing **20**, rotates by a driving force from the actuator **30**, contacts an arm **50** that rotates together with the pedal **120**, and is capable of applying a reaction force to the pedal **120** against the driver's stepping force.

(27) More specifically, the actuator housing **20** includes a housing body **201**, a pedestal portion **21**, and an actuator-side extender **22**. The housing body **201** has a space formed therein for accommodating the actuator **30** and the like.

(28) The pedestal portion **21** has a pedestal body **211** and a pedestal leg **212**. The pedestal body **211** has a plate shape, integrally with the housing body **201**. A total of two pedestal legs **212** are

provided, one at each end of the pedestal body **211** in a plate surface direction (the z-axis direction in FIG. **1**). The pedestal leg **212** has one body, integrally with the pedestal body **211**, to extend obliquely from the pedestal body **211** in a plate-thickness direction.

(29) The actuator housing **20** is attached to the floor panel **2**, by fixing the pedestal leg **212** of the pedestal portion **21** to the wall surface **7** of the floor panel **2** with, for example, a vehicle-body-side bolt **4** provided on the floor panel **2** of the vehicle **1** and a nut **5** screwed onto the vehicle-body-side bolt **4**. The attachment of the reaction force applying device **10** including the actuator housing **20** to the vehicle **1** will further be described later.

(30) The actuator-side extender **22** is formed integrally with the pedestal body **211** of the pedestal portion **21**, extending downward from the pedestal body **211**. The actuator-side extender **22** is formed into a substantially L-shaped plate shape, for example, so that an end opposite to the pedestal body **211** is bent (see FIG. **2**).

(31) The actuator **30** is, for example, an electric motor, and is housed within the housing body **201** of the actuator housing **20**. The actuator **30** can output torque as a driving force when receiving a supply of electric power. The ECU can control a supply of electric power to the actuator **30**, for controlling an operation of the actuator **30**. A speed reducer (not shown) consisting of a plurality of gears is provided in the housing body **201**. The speed reducer can reduce and output the torque of the actuator **30**.

(32) One end of the lever **40** is rotatably supported by the actuator housing **20** for a rotation about a rotation axis Ax**3**. One end of the lever **40** is connected to the speed reducer in the housing body **201**. The lever **40** rotates about the rotation axis Ax**3** by a driving force from the actuator **30** that is output from the speed reducer.

(33) In the present embodiment, the arm **50** is provided in the accelerator device **100**. The arm **50** is formed to have a bending rod shape, and is attached to the pedal **120** with one end thereof fixed to the pedal **120**. Such a configuration allows the arm **50** to rotate together with the pedal **120**. Therefore, a rotation axis Ax**2** of the arm **50** coincides with the rotation axis Ax**1** of the pedal **120**.

(34) An other end of the lever **40**, that is, an end opposite to the rotation axis Ax**3**, is contactable with an other end of the arm **50**, that is, an end opposite to the pedal **120**. The lever **40** is capable of applying the reaction force F**2** to the pedal **120** via the arm **50**, by (i) being rotated by the driving force from the actuator **30**, (ii) coming into contact with the other end of the arm **50** that rotates together with the pedal **120**, and (iii) applying the reaction force F**2** to the arm **50** against the driver's stepping force F**1**.

(35) The connected part **61** is provided in the pedal housing **110**. The connecting part **71** is provided at the actuator housing **20**, and is connected to the connected part **61**.

(36) In the present embodiment, two connected parts **61** are provided. Two connecting parts **71** are also provided.

(37) More specifically, the pedal housing **110** is provided with a pedal-side extender **23**. The pedal-side extender **23** has one body formed integrally with the housing body **111** of the pedal housing **110**, extending upward from the housing body **111**. The pedal-side extender **23** is formed, for example, in a rectangular plate shape (see FIGS. **1** and **2**). The pedal-side extender **23** is formed to be able to come into contact with the end of the actuator-side extender **22** on the side opposite to the pedestal portion **21**.

(38) The connected parts **61** are formed at two locations on the pedal-side extender **23**, that is, two connected parts **61** are formed. The connecting parts **71** are formed at two locations on an end portion of the actuator-side extender **22**, i.e., on an opposite side from the pedestal portion **21**, thereby two connecting parts **71** are formed. The two connecting parts **71** are respectively connected by coming into contact with the two connected parts **61**, respectively (see FIGS. **3** and **4**).

(39) In the present embodiment, a bolt **80** that fastens the connected part **61** and the connecting part **71** is further provided.

(40) More specifically, as shown in FIG. **4**, the bolt **80** has a bolt shaft **81** and a bolt head **82**. The bolt shaft **81** is formed into a rod shape, and has a male thread groove formed on its outer peripheral wall. The bolt head **82** is provided integrally with the bolt shaft **81** at one end of the bolt shaft **81**. An outer diameter of the bolt head **82** is larger than an outer diameter of the bolt shaft **81**.
(41) A bolt hole **221** passing through the actuator-side extender **22** in the plate-thickness direction is formed at a position corresponding to the connecting part **71** of the actuator-side extender **22**. In other words, an area around the bolt hole **221** of the actuator-side extender **22** corresponds to the connecting part **71**. A bolt hole **231** is formed at a position corresponding to the connected part **61** of the pedal-side extender **23**. In other words, a periphery of the bolt hole **231** of the pedal-side extender **23** corresponds to the connected part **61**. A female thread groove is formed on an inner circumferential wall of the bolt hole **231**. The bolt **80** fastens, or connects, the connected part **61** and the connecting part **71**, when the bolt shaft **81** passes through the bolt hole **221** and is screwed into the bolt hole **231**, and the bolt head **82** engages the actuator-side extender **22**.
(42) By connecting the connected part **61** and the connecting part **71** and fastening the connected part **61** and the connecting part **71** with the bolt **80**, a relative position of the pedal housing **110** and the actuator housing **20** is defined.
(43) Next, a procedure for attaching the accelerator device **100** and the reaction force applying device **10** to the vehicle **1**, and assembling the accelerator device **100** and the reaction force applying device **10** will be described.
(44) In the present embodiment, the accelerator device **100** is first attached to the vehicle **1** by fixing the pedal housing **110** to the floor panel **2** with the attachment bolts **3**. Then, the accelerator device **100** and the reaction force applying device **10** are assembled. Specifically, the connected part **61** on the accelerator device **100** and the connecting part **71** on the reaction force applying device **10** are connected, and the connected part **61** and the connecting part **71** are fastened with the bolt **80**.
(45) Then, the reaction force applying device **10** is attached to the vehicle **1** by fixing the actuator housing **20** to the floor panel **2**. Specifically, the reaction force applying device **10** is attached to the vehicle **1**, by (a) passing each of the two vehicle-body-side bolts **4** through each of two attachment holes **213** formed on the pedestal leg **212** of the actuator housing **20**, and (b) screwing the nut **5** onto the vehicle-body-side bolt **4** to fix the pedestal leg **212** onto the floor panel **2** (see FIG. **5**).
(46) The above-described procedure completes the attachment of the accelerator device **100** and the reaction force applying device **10** to the vehicle **1**, and the assembly of the accelerator device **100** and the reaction force applying device **10**.
(47) As shown in FIG. **5**, an inner diameter of the attachment hole **213** is greater than an outer diameter of the vehicle-body-side bolt **4**, by a predetermined amount. The predetermined amount can be set by an addition of (i) a difference between an inner diameter of the bolt hole **113** formed in the housing attachment portion **112** of the pedal housing **110**, and an outer diameter of the threaded portion of the attachment bolt **3**, (ii) a positional variation between the bolt hole **113**, the connected part **61** and the bolt hole **231**, and (iii) a positional variation between the connecting part **71** and the bolt hole part **221**, and the attachment hole **213**. Therefore, a tolerance of each of the above-described factors can be absorbed on an actuator housing **20** side, and the attachment of the accelerator device **100** and the reaction force applying device **10** to the vehicle **1** and the assembly of the accelerator device **100** and the reaction force applying device **10** are facilitated.
(48) As explained above, in the present embodiment, the connected part **61** is provided in the pedal housing **110**. The connecting part **71** is provided in the actuator housing **20**, and is connected to the connected part **61**.
(49) In the present embodiment, the connected part **61** provided on the pedal housing **110** of the accelerator device **100** and the connecting part **71** provided on the actuator housing **20** of the reaction force applying device **10** are connected. Therefore, when the pedal housing **110** and the actuator housing **20** are attached to the vehicle **1**, variation of the relative position of the pedal

housing **110** and the actuator housing **20** can be reduced. Thereby, the deviation of the contact point between the lever **40** of the reaction force applying device **10** and the arm **50** of the accelerator device **100** can be reduced. Therefore, the deviation amount of reaction force with respect to the target reaction force can be reduced. Thus, it is possible to prevent deteriorated feeling of driver notification (notification for a driver) using the reaction force.

(50) Further, in the present embodiment, two connected parts **61** are provided. Two connecting parts **71** are also provided. Therefore, relative rotation between the pedal housing **110** and the actuator housing **20** is suppressed, thereby further reducing variation of relative position therebetween.

(51) Further, the present embodiment includes the bolt **80** that fastens the connected part **61** and the connecting part **71**. Therefore, even after the assembly of the accelerator device **100** and the reaction force applying device **10**, the connection between the connected part **61** (corresponding to a first connection part) and the connecting part **71** (corresponding to a second connection part) is maintained, and the variation of the relative position between the pedal housing **110** and the actuator housing **20** can be reduced over a long period of time.

Second Embodiment

(52) A part of the reaction force applying device and the accelerator device according to the second embodiment are shown in FIGS. **6** and **7**. The second embodiment differs from the first embodiment in the configurations of the connected part and the connecting part.

(53) In the present embodiment, an actuator-side extender **22** has, formed thereon, a press-fit hole **222** instead of the bolt hole **221**. The press-fit hole **222** is formed in a rectangular shape to penetrate the actuator-side extender **22** in the plate-thickness direction at an end of the actuator-side extender **22** opposite to a pedestal portion **21**. A connecting part **72** is formed on an inner wall of the press-fit hole **222** and around the press-fit hole **222**. That is, the inner wall of the press-fit hole **222** and a periphery of the press-fit hole **222** on the actuator-side extender **22** correspond to the connecting part **72**.

(54) A connected part **62** is formed on a pedal-side extender **23** in place of the bolt hole **231**. The connected part **62** is formed to protrude in a rectangular column shape from a surface of the pedal-side extender **23** on an actuator-side extender **22** side in the plate-thickness direction.

(55) The connecting part **72** has a rectangular cross-sectional shape taken along a plane perpendicular to the plate-thickness direction of the actuator-side extender **22**, that is, a non-perfect circular shape. The connected part **62** has a rectangular cross-sectional shape taken along a plane perpendicular to the plate-thickness direction of the pedal-side extender **23**, that is, a non-perfect circular shape.

(56) In the present embodiment, the connected part **62** and the connecting part **72** are connected by press fitting.

(57) More specifically, when assembling the accelerator device **100** and the reaction force applying device **10**, the connected part **62** is press-fitted into the press-fit hole **222**, that is, the connecting part **72**. Thereby, the connection between the connected part **62** and the connecting part **72** is complete, and the assembly of the accelerator device **100** and the reaction force applying device **10** is complete.

(58) As explained above, the cross-sectional shape of the connected part **62** is a non-perfect circular shape. The cross-sectional shape of the connecting part **72** is a non-perfect circle. Therefore, relative rotation between the pedal housing **110** and the actuator housing **20** is suppressed, thereby further reducing variation of relative position therebetween.

(59) Further, in the present embodiment, the connected part **62** and the connecting part **72** are connected by press fitting. Therefore, the connected part **62** and the connecting part **72** can be easily connected, and, even after assembly of the accelerator device **100** and the reaction force applying device **10**, the connection between the connected part **62** and the connecting part **72** are maintained, and variation of the relative position of the pedal housing **110** and the actuator housing

**20** can be reduced over a long period of time.

Third Embodiment

(60) A part of a reaction force applying device and an accelerator device according to the third embodiment are shown in FIGS. **8** and **9**. The third embodiment differs from the second embodiment in the configurations of the connected part and the connecting part.

(61) In the present embodiment, an actuator-side extender **22** is formed with a snap-fit hole **223** instead of the press-fit hole **222**. The snap-fit hole **223** is formed in a rectangular shape to penetrate an actuator-side extender **22** in the plate-thickness direction at an end of the actuator-side extender **22** on the opposite side from a pedestal portion **21**. A connecting part **73** is formed on an inner wall of the snap-fit hole **223** and around the snap-fit hole **223**. That is, the inner wall of the snap-fit hole **223** and a periphery of the snap-fit hole **223** on the actuator-side extender **22** correspond to the connecting part **73**.

(62) A connected part **63** is formed on a pedal-side extender **23** in place of the connected part **62**. The connected part **63** has a connected part body **631** and an engager **632**. The connected part body **631** is formed to protrude in a rectangular column shape in the plate-thickness direction from the surface of the pedal-side extender **23** on an actuator-side extender **22** side. Two connected part bodies **631** are formed on the pedal-side extender **23**. The connected part body **631** is inserted into the snap-fit hole **223**, for an end thereof opposite to the pedal-side extender **23** to protrude from the actuator-side extender **22**.

(63) A size d**1** of the snap-fit hole **223** in the z-axis direction is approximately the same as a size d**2** of the connected part body **631** in the z-axis direction (see FIG. **8**). A size d**3** of the snap-fit hole **223** in the y-axis direction is greater than a size d**4** between outer walls of the two connected part bodies **631** facing away from each other in the y-axis direction (see FIG. **9**).

(64) The engagers **632** are formed integrally with the connected part bodies **631**, respectively protruding away in the y-axis direction from the ends of the two connected part bodies **631** opposite to the pedal-side extender **23**. The engager **632** has an inclined surface **633** and an engaging surface **634**. The inclined surface **633** is formed in a rectangular planar shape to be inclined with respect to the xz plane. The engaging surface **634** is formed in a rectangular planar shape parallel to the yz plane. One end of the inclined surface **633** in the x-axis direction is connected to the connected part body **631**, and the other end of the inclined surface **633** in the x-axis direction is connected to the engaging surface **634**. One end of the engaging surface **634** in the y-axis direction is connected to the inclined surface **633**, and the other end of the engaging surface **634** in the y-axis direction is connected to the connected part body **631** (see FIG. **9**).

(65) The connecting part **73** has a rectangular cross-sectional shape taken along a plane perpendicular to the plate-thickness direction of the actuator-side extender **22**, that is, a non-perfect circular shape. The connected part **63** has a rectangular cross-sectional shape taken along a plane perpendicular to the plate-thickness direction of the pedal-side extender **23**, that is, a non-perfect circular shape.

(66) In the present embodiment, the connected part **63** and the connecting part **73** are connected by snap fitting.

(67) More specifically, when assembling the accelerator device **100** and the reaction force applying device **10**, the connected part **63** is inserted into the snap fit hole **223**, that is, the connecting part **73**. During assembling, the connected part **63** has the two inclined surfaces **633** fittingly slid on the inner wall of the snap-fit hole **223**, thereby deforming the two connected part bodies **631** to bring the ends thereof on the opposite side from the pedal-side extender **23** closer to each other in the y-axis direction. When the actuator-side extender **22** and the pedal-side extender **23** come into contact, the deformation of the two connected part bodies **631** returns to the original state, and the engaging surface **634** engages a part of the surface of the actuator side extender **22**, that is, a periphery of the snap-fit hole **223** or the connecting part **73** in other words, opposite to the pedal-side extender **23**. Thereby, the connection between the connected part **63** and the connecting part **73**

is complete, and the assembly of the accelerator device **100** and the reaction force applying device **10** is complete.
(68) As explained above, the cross-sectional shape of the connected part **63** is a non-perfect circular shape. The cross-sectional shape of the connecting part **73** is a non-perfect circular shape. Therefore, as in the second embodiment, relative rotation between the pedal housing **110** and the actuator housing **20** is suppressible, and variation in the relative position thereof is further reducible.
(69) Further, in the present embodiment, the connected part **63** and the connecting part **73** are connected by snap fitting. Therefore, the connected part **63** and the connected part **73** are easily and reliably connectable, and the connection between the connected part **63** and the connected part **73** is maintained even after assembly of the accelerator device **100** and the reaction force applying device **10**, and variation of the relative position of the pedal housing **110** and the actuator housing **20** can be reduced over a long period of time.
Other Embodiments
(70) In the embodiments described above, an example is shown, in which the lever **40** comes into contact with the arm **50** that rotates together with the pedal **120**, and applies a reaction force to the pedal **120**. On the other hand, in other embodiments, the lever **40** may directly contact the pedal **120** and apply a reaction force to the pedal **120**, without providing the arm **50** on the pedal **120**, for example.
(71) Further, in the second and third embodiments, an example is shown in which one connected part and one connecting part are provided. On the other hand, in other embodiments, two or more connected parts and two or more connecting parts may be provided. In such case, relative rotation between the pedal housing and the actuator housing is suppressible, and variation of their relative position can be further reduced.
(72) Further, in the second embodiment, an example is shown in which the connected part and the connecting part are connected by press fit, and in the third embodiment, an example is shown in which the connected part and the connecting part are connected by snap fitting. On the other hand, in other embodiments, the connected part and the connecting part may be connected by press-fitting and snap-fitting.
(73) Further, in the second embodiment, an example is shown in which the connected part and the connecting part have a rectangular cross-sectional shape. On the other hand, in other embodiments, the cross-sectional shapes of the connected part and the connected part may be non-circular shapes such as elliptical shapes, oval shapes, polygonal shapes other than rectangles and the like.
(74) Further, in other embodiments, the wall surface of the floor panel of the vehicle to which the reaction force applying device and the accelerator device are attached may be formed non-parallel to the yz plane. That is, the wall surface of the floor panel may be formed at any angle with respect to the vehicle.
(75) Thus, the present disclosure is not limited to the above-described embodiments, but can be implemented in various forms without departing from the scope thereof.
(76) The present disclosure has been described based on the embodiments. However, the present disclosure is not limited to the embodiments and disclosed structures. The present disclosure also encompasses various modifications and variations within the scope of equivalents. Furthermore, various combinations and formations, and other combinations and formations including one, more than one or less than one element may be encompassed within the idea of the present disclosure.

## Claims

1. A reaction force applying device configured to apply, against a stepping force of a driver, a reaction force to a pedal of an accelerator device that includes: the pedal to be stepped by the driver; and a pedal housing provided to rotatably support the pedal and to be attached to a vehicle,

the reaction force applying device comprising: an actuator housing to be attachable to the vehicle; an actuator provided in the actuator housing; a lever provided at the actuator housing, to be rotatable by receiving a driving force from the actuator, to contact the pedal or an arm rotating with the pedal, and to apply the reaction force to the pedal with respect to the stepping force of the driver; at least one connected part provided in the pedal housing; and at least one connecting part provided in the actuator housing and directly connected to the at least one connected part without through the lever and the arm, wherein the actuator housing is attached to the vehicle at a position away from the pedal housing by a predetermined distance.

2. The reaction force applying device of claim 1, wherein the at least one connected part is comprised of a plurality of connected parts, and the at least one connected part is comprised of a plurality of connecting parts.

3. The reaction force applying device of claim 1, wherein a cross-sectional shape of the at least one connected part is a non-perfect circular shape, and a cross-sectional shape of the at least one connecting part is a non-perfect circular shape.

4. The reaction force applying device of claim 1, further comprising: a bolt that fastens the at least one connected part and the at least one connecting part together.

5. The reaction force applying device of claim 1, wherein the at least one connected part and the at least one connecting part are connected by press fitting.

6. The reaction force applying device of claim 1, wherein the at least one connected part and the at least one connecting part are connected by snap fitting.

7. A reaction force applying device to apply a reaction force to a pedal of a vehicle against a pedal stepping force of a driver, the reaction force applying device comprising: an actuator housing to be attached to the vehicle; an actuator provided in the actuator housing; a lever provided at the actuator housing, to be rotatable by receiving a driving force from the actuator, to contact the pedal or an arm rotating with the pedal, and to apply the reaction force to the pedal with respect to the stepping force of the driver; a first connection part provided in a pedal housing in which the pedal is provided; and a second connection part provided in the actuator housing and directly connected to the first connection part without through the lever and the arm, wherein the actuator housing is attached to the vehicle at a position away from the pedal housing by a predetermined distance.

8. A reaction force applying device configured to apply, against a stepping force of a driver, a reaction force to a pedal of an accelerator device that includes: the pedal to be stepped by the driver; and a pedal housing provided to rotatably support the pedal and to be attached to a vehicle, the reaction force applying device comprising: an actuator housing to be attachable to the vehicle; an actuator provided in the actuator housing; a lever provided at the actuator housing, to be rotatable by receiving a driving force from the actuator, to contact the pedal or an arm rotating with the pedal, and to apply the reaction force to the pedal with respect to the stepping force of the driver; at least one connected part provided in the pedal housing; and at least one connecting part provided in the actuator housing and connected to the at least one connected part, wherein the actuator housing is attached to the vehicle at a position away from the pedal housing by a predetermined distance, and a bolt that fastens the at least one connected part and the at least one connecting part together.