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United States Patent	12388316
Kind Code	B2
Date of Patent	August 12, 2025
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Rotating device as an actuator

Abstract

A rotating device includes a housing, a motor, and one or more gears. The housing includes a first housing and a second housing engaging with the first housing. The motor and the one or more gears are accommodated in the housing. The first housing and the second housing oppose one another in a first direction. A side wall part of the second housing is provided with a first hook, and a side wall part of the first housing is provided with a first protruding part. The first protruding part engages with the first hook. A surface of the first hook engaging with the first protruding part and a surface of the first protruding part engaging with the first hook are in contact with one another in the first direction. The surface of one of the first hook and the first protruding part is inclined with respect to the surface of the other of the first hook and the first protruding part, and the surface of the first protruding part faces the side wall part of the first housing.

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Appl. No.: 18/307075

Filed: April 26, 2023

Prior Publication Data

Document Identifier	Publication Date
US 20240079925 A1	Mar. 07, 2024

Foreign Application Priority Data

JP	2022-075917	May. 02, 2022
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Publication Classification

Int. Cl.: H02K5/04 (20060101); H02K7/116 (20060101)

U.S. Cl.:

CPC H02K5/04 (20130101); H02K7/116 (20130101);

Field of Classification Search

CPC: H02K (5/04); H02K (5/08); H02K (5/22); H02K (5/225); H02K (7/116); H02K (7/1163); H02K (7/1166)

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) This application claims benefit of priority to Japanese Patent Application No. JP2022-075917 filed on May 2, 2022. The entire contents of the above-identified application are hereby incorporated by reference.

TECHNICAL FIELD

(2) The present invention relates to a rotating device.

BACKGROUND ART

(3) An example of a known rotating device used in an actuator or the like includes a rotating device accommodating a motor and gears within a pair of engaging housings. For example, a known

motor apparatus includes a tongue-like protruding part being elastically deformable and formed on either a case or a cover, and a catch part being engageable with the protruding part and formed on the other, and the protruding part and the catch part engage by snap-fit.

CITATION LIST

Patent Literature

(4) PTL 1: JP 2016-540941 A PTL 2: JP 2014-027773 A

SUMMARY OF INVENTION

Technical Problem

(5) However, when a housing is assembled using an engagement part, the engagement is easily disengaged when a reaction force caused by vibration of the motor or the like is applied to the engagement part. This may decrease the reliability of the rotating device.

(6) An object of one aspect is to realize a rotating device with high reliability.

Solution to Problem

(7) In one aspect, a rotating device includes a housing, a motor, and one or more gears. The housing includes a first housing and a second housing. The second housing engages with the first housing. The motor and the one or more gears are accommodated in the housing. The first housing and the second housing oppose one another in a first direction. A side wall part of the second housing is provided with a first hook, and a side wall part of the first housing is provided with a first protruding part. The first protruding part engages with the first hook. A surface of the first hook engaging with the first protruding part and a surface of the first protruding part engaging with the first hook are in contact with one another in the first direction. The surface of one of the first hook and the first protruding part is inclined with respect to the surface of the other of the first hook and the first protruding part, and the surface of the first protruding part faces the side wall part of the first housing.

(8) According to an aspect, a rotating device with high reliability can be realized.

Description

BRIEF DESCRIPTION OF DRAWINGS

(1) FIG. 1 is a perspective view illustrating an example of a rotating device according to an embodiment.

(2) FIG. 2 is a plan view illustrating a rotating device according to an embodiment with a first housing removed.

(3) FIG. 3 is a perspective view illustrating an example of the first housing according to the embodiment.

(4) FIG. 4 is a perspective view illustrating an example of a second housing according to the embodiment.

(5) FIG. 5 is a cross-sectional perspective view illustrating an example of a housing according to the embodiment.

(6) FIG. 6 is a cross-sectional perspective view illustrating another example of a housing according to the embodiment.

(7) FIG. 7 is a cross-sectional view illustrating an example of a first engagement part of the rotating device according to the embodiment.

(8) FIG. 8 is a cross-sectional view illustrating an example of a second engagement part of the rotating device according to the embodiment.

(9) FIG. 9 is an enlarged cross-sectional view illustrating an example of the first engagement part of the rotating device according to the embodiment.

DESCRIPTION OF EMBODIMENTS

(10) An embodiment of a rotating device disclosed in the present application is described below in

detail with reference to the drawings. The dimensional relationship of elements and the ratio of the elements in the drawings may differ from an actual configuration. The drawings may each include parts having mutually different dimensional relationships and proportions. In order to facilitate description, each drawing may be illustrated using a coordinate system, where the extension direction of a rotation shaft **31** of a motor **3** described below is defined as the X-axis direction, and the extension direction of an output shaft **51** described below orthogonal to the rotation shaft **31** is defined as the Z-axis direction.

EMBODIMENTS

(11) FIG. **1** is a perspective view illustrating an example of a rotating device according to the embodiment. FIG. **2** is a plan view illustrating the rotating device according to the embodiment with a first housing removed. FIG. **3** is a perspective view for describing an example of the first housing according to the embodiment. FIG. **4** is a perspective view for describing an example of a second housing according to the embodiment. FIG. **5** is a cross-sectional perspective view illustrating an example of a housing according to the embodiment. FIG. **6** is another cross-sectional perspective view illustrating an example of the housing according to the embodiment. FIG. **5** illustrates a cross section taken along a plane **S1** in FIG. **1**, and FIG. **6** illustrates a cross section taken along a plane **S2** in FIG. **1**. FIGS. **5** and **6** illustrate a first housing **21** and a second housing **22** in a joined state, and the internal structure of a rotating device **1** illustrated in FIG. **2** is not illustrated. For example, the rotating device **1** according to the embodiment can be suitably used as an actuator used in an air conditioning system for a vehicle and can control the turning operation of a louver for controlling air flow and the like.

(12) As illustrated in FIGS. **1** and **2**, the rotating device **1** according to the embodiment includes a housing **2** and the motor **3** and a set of gears **6** accommodated in the housing **2**. As illustrated in FIGS. **1** and **5**, the housing **2** includes the first housing **21** and the second housing **22** for engaging with the first housing **21**. The first housing **21** and the second housing **22** oppose one another in the Z-axis direction. In other words, the housing **2** is configured so that the first housing **21** including an opening part **212** illustrated in FIG. **3** and the second housing **22** including an opening part **222** illustrated in FIG. **4** connect in the Z-axis direction with the opening parts **212** and **222** in an opposing state. The Z-axis direction is an example of a first direction.

(13) As illustrated in FIG. **2**, the rotating device **1** internally includes the motor **3**, the plurality of gears (hereinafter referred to as a set of gears) **6** for transmitting power from the motor **3**, a sensor **7** for detecting the rotation angle of an output gear **50** included in the set of gears **6**, and the like. The motor **3** and the set of gears **6** are accommodated in the housing **2**. The set of gears **6** is an example of a plurality of gears.

(14) The set of gears **6** includes a worm **10** mounted at the rotation shaft **31** of the motor **3**, a first transmission gear **61**, a second transmission gear **62**, and the output gear **50**. Instead of the set of gears **6**, the rotating device **1** may have a configuration including a single gear. As illustrated in FIG. **2**, the first transmission gear **61** is located on the positive direction side of the worm **10** in the Y-axis direction.

(15) Rotation of the worm **10** is transmitted to a helical gear **61a** of the first transmission gear **61** and is transmitted to the second transmission gear **62** via a gear **61b** coaxially provided with the helical gear **61a** and having a smaller diameter than the helical gear **61a**. The rotation of the second transmission gear **62** is transmitted to the output gear **50**. The output gear **50** is provided with the output shaft **51**. The rotation shafts of the first transmission gear **61** and the second transmission gear **62** extend in the direction (Z-axis direction) of the output shaft **51** and extend in a direction intersecting the rotation axis direction (X-axis direction) of the worm **10**.

(16) As described above, the rotation of the motor **3** is decelerated at a predetermined deceleration rate and output from the output shaft **51** to the outside. Then, the rotation angle of the output gear **50** is detected by the sensor **7**. Information of the rotation angle of the output gear **50** detected by the sensor **7** is transmitted to the outside via a group of terminals **4** illustrated in FIG. **2**, for

example. The group of terminals **4** may be connected to the motor **3** via an FPC **8** illustrated in FIG. **2**, for example. In each diagram, a hole part, in the housing **2**, the output shaft **51** being passed through the hole part and the detailed internal structure of the housing **2** are omitted.

(17) Note that the sensor **7** may detect the rotation speed rather than the rotation angle of the output gear **50** or may detect both the rotation angle and the rotation speed. In the present embodiment, a DC motor is employed as the motor **3**, but a brushless motor or a stepping motor may be employed. In a case where a brushless motor or a stepping motor is employed, the rotating device **1** may not require the sensor **7**.

(18) As illustrated in FIG. **5**, the first housing **21** includes a surface part **210** serving as a top surface part of the housing **2** and a side wall part **211** provided at an outer circumferential part of the surface part **210**. The opening part **212** is surrounded by the side wall part **211**. On the other hand, as illustrated in FIG. **5**, the second housing **22** includes a surface part **220** serving as a bottom surface part of the housing **2** and a side wall part **221** provided at an outer circumferential part of the surface part **220**. The opening part **222** is surrounded by the side wall part **221**. Accommodating parts **213** and **223** accommodating the motor **3** illustrated in FIG. **2** are formed in the opening parts **212** and **222**, respectively. The housing **2** is formed of resin material with elasticity or deformability, such as polypropylene, polyethylene terephthalate, ABS, or polycarbonate.

(19) A tab (hereinafter, referred to as an attachment tab) **93** is formed, the tab outwardly protruding from each end part of one side of the first housing **21** and the second housing **22**. The attachment tabs **93** are provided with holes (hereinafter, referred to as coupling holes) **94** accepting fasteners (not illustrated) as predetermined fixing members. The joined first housing **21** and second housing **22** are securely coupled together with the predetermined fasteners through the four coupling holes **94** to form the integrated housing **2**.

(20) In the configuration of the housing **2** described above, in the present embodiment, boss parts **29** are provided at corner parts of the side wall part **211** forming the outer circumferential part of the first housing **21**, and second through holes **292** are provided at corner parts of the second housing **22**. In other words, in the first housing **21**, the cylindrical boss parts **29** including first through holes **291** are formed so as to protrude from the surface part **210**, and fasteners, such as bolts and screws for example, can be inserted into the first through holes **291**. The second housing **22** is provided with the second through holes **292** engaging with the boss parts **29**.

(21) A plurality of the boss parts **29** are provided, and a corresponding number of the second through holes **292** are also provided. The plurality of boss parts **29** are provided at a plurality of corner parts of the first housing **21**, respectively, and the plurality of second through holes **292** are also provided at a plurality of corner parts of the second housing **22**, respectively. In the present embodiment, the surface part **210** of the first housing **21** and the surface part **220** of the second housing **22** have a substantially rectangular shape in plan view, and the boss parts **29** and the second through holes **292** are provided at the corner parts. In the embodiment, the boss parts **29** and the second through holes **292** are formed at three of the four corner parts, but are not limited thereto, and may be provided at all four corner parts or may be provided at other locations.

(22) Extending parts **219** and **229** corresponding to one another are formed at the first housing **21** and the second housing **22**, respectively. The extending parts **219** and **229** protrude in the X-axis positive direction, that is the direction of the group of terminals **4** extending in the present embodiment. The extending parts **219** and **229** are joined together to form a connector part **209** illustrated in FIG. **1**. The group of terminals **4** illustrated in FIG. **2** are held at the connector part **209**.

(23) The side wall part **221** of the second housing **22** includes a first hook **240**, and the side wall part **211** of the first housing **21** includes a first protruding part **230** for engaging with the first hook **240**. The first hook **240** is supported by a support part **224**. The first protruding part **230** is integrally formed with an outer circumferential part of the side wall part **211** of the first housing **21**. The first hook **240** and the support part **224** are integrally formed with the side wall part **221** of the

second housing **22**. In the embodiment, the first protruding part **230** and the first hook **240** are formed at the side wall parts **211** and **221** on the X-axis positive direction side, that is the side the extending part **219** extends. Hereinafter, the first protruding part **230** and the first hook **240** may be collectively referred to as a first engagement part.

(24) As illustrated in FIG. **1**, the second housing **22** includes a second hook **260**, and the first housing **21** includes a second protruding part **250**. The second hook **260** is supported by a support part **225**. The second protruding part **250** is integrally formed with an outer circumferential part of the side wall part **211** of the first housing **21**. The second hook **260** and the support part **225** are integrally formed with the side wall part **221** of the second housing **22**. The second hook **260** engages with the second protruding part **250** of the first housing **21**. In the embodiment, as illustrated in FIGS. **3** and **4**, the second protruding part **250** and the second hook **260** are formed at the side wall parts **211** and **221**, respectively, on the X-axis negative direction side, the Y-axis positive direction side, and the Y-axis negative direction side. Hereinafter, the second protruding part **250** and the second hook **260** may be collectively referred to as a second engagement part.

(25) A hook may be formed at the first housing **21**, and a protruding part may be formed at the second housing **22**. In the embodiment, as illustrated in FIG. **1**, a third hook **270** is formed at the extending part **219** of the first housing **21**, and a third protruding part **280** is formed at the extending part **229** of the second housing **22**.

(26) As illustrated in FIG. **3**, a first opposing surface **215** protruding in the Z-axis negative direction and a second opposing surface **217** located on the Z-axis positive direction side are formed at the end part of the side wall part **211** of the first housing **21** on the Z-axis negative direction side. In the embodiment, the first opposing surface **215** is formed at a position further inward, that is, closer to the opening part **212**, than the second opposing surface **217**. In a similar manner, as illustrated in FIG. **4**, a fourth opposing surface **228** protruding in the Z-axis positive direction and a third opposing surface **226** located on the Z-axis negative direction side are provided at the end part of the side wall part **221** of the second housing **22** on the Z-axis positive direction side. As illustrated in FIG. **4**, the third opposing surface **226** is formed at a position further inward, that is, closer to the opening part **222**, than the fourth opposing surface **228**. The first opposing surface **215** and the second opposing surface **217** are examples of end parts of a side wall part of a first housing, and the third opposing surface **226** and the fourth opposing surface **228** are examples of end parts of a side wall part of a second housing.

(27) In the embodiment, as illustrated in FIGS. **5** and **6**, in the housing **2**, the fourth opposing surface **228** of the second housing **22** is formed at a position opposing the second opposing surface **217** of the first housing **21**, and the third opposing surface **226** is formed at a position opposing the first opposing surface **215**. With this configuration, the first opposing surface **215** and the second opposing surface **217** engage with the fourth opposing surface **228** and the third opposing surface **226**.

(28) In this manner, the housing **2** illustrated in FIG. **1** is formed by abutting the first housing **21** and the second housing **22** against one another. In other words, by engaging the first hook **240** of the second housing **22** with the first protruding part **230** of the first housing **21**, the first housing **21** and the second housing **22** are integrated, and the housing **2** accommodating the motor **3**, the set of gears **6**, and the like described above is formed.

(29) In the embodiment, as illustrated in FIGS. **7** and **8**, the shape of the first engagement part is different from the shape of the second engagement part. FIG. **7** is a cross-sectional view illustrating an example of the first engagement part of the rotating device according to the embodiment. FIG. **8** is a cross-sectional view illustrating an example of the second engagement part of the rotating device **1** according to the embodiment. FIG. **7** is an enlarged view of a portion illustrated in a frame F1 in FIG. **5**. FIG. **8** is an enlarged view of a portion illustrated in a frame F2 in FIG. **6**. In FIG. **7**, the support part **224** of the second housing **22**, not present on the plane S1 illustrated in FIG. **1**, is illustrated with a dashed line. The same applies to FIG. **9** described below. In FIG. **8**, the support

part **225** of the second hook **260** of the second housing **22**, not present on the plane **S2** illustrated in FIG. **1**, is illustrated with a dashed line.

(30) As illustrated in FIG. **7**, the first hook **240** formed at the second housing **22** includes an inclined surface **241**. The inclined surface **241** is in contact with the first protruding part **230** formed at the first housing **21**. Specifically, in the Z-axis direction, the inclined surface **241** of the first hook **240** engaging with the first protruding part **230** and an inclined surface **231** of the first protruding part **230** engaging with the first hook **240** are in contact with one another. In a similar manner, as illustrated in FIG. **8**, an inclined surface **261** of the second hook **260** formed at the second housing **22** is in contact with an inclined surface **251** of the second protruding part **250** formed at the first housing **21**. The inclined surface **241** is an example of a surface of a first hook, and the inclined surface **231** is an example of a surface of a first protruding part.

(31) As illustrated in FIG. **8**, the inclined surface **261** of the second hook **260** is inclined so as to oppose the side wall part **211** of the first housing **21**. In other words, the inclined surface **251** of the second protruding part **250** faces the outside of the second housing **22**, and the inclined surface **261** of the second hook **260** faces the inside of the second housing **22**. The inclined surfaces **251** and **261** may extend in the X-axis direction, that is, a direction substantially orthogonal to the Z-axis direction, for example. In this case, the inclined surfaces **251** and **261** face a direction substantially orthogonal to the side wall part **221** of the second housing **22**.

(32) As illustrated in FIG. **7**, the inclined surface **231** of the first protruding part **230** faces the side wall part **211** of the first housing **21**. The inclined surface **241** of the first hook **240** is formed inclined at substantially the same angle as the inclined surface **231**. That is, the inclined surface **241** faces the direction away from the side wall part **221** of the second housing **22**. In this case, the inclined surface **231** of the first protruding part **230** faces the inside of the first housing **21**, and the inclined surface **241** of the first hook **240** faces outward from the side wall part **221** of the first housing **21**. That is, the first protruding part **230** and the first hook **240** according to the embodiment have a so-called reverse tapered shape.

(33) The first hook **240** is in contact with the side wall part **211** of the first housing **21**. Specifically, as illustrated in FIG. **9**, a side surface **243** of the first hook **240** is in contact with the side wall part **211** of the first housing **21**. FIG. **9** is an enlarged cross-sectional view illustrating an example of the first engagement part of the rotating device according to the embodiment. As illustrated in FIG. **9**, the side surface **243** of the first hook **240** extends in substantially the same direction as the Z-axis direction. The portion, opposing the side surface **243**, of the side wall part **211** of the first housing **21** extends in substantially the same direction as the Z-axis direction.

(34) In the housing **2**, when an external force acts in the direction of separation for the first housing **21** and the second housing **22**, the reaction force applied to the hook and the protruding part acts perpendicular to the tangent line at the contact surface of contact between the hook and the protruding part. For example, the force acts in the direction indicated by an arrow **D0** at the second hook **260** and the second protruding part **250** illustrated in FIG. **8**. In this case, a force acting in a direction **D9** of separation of the second hook **260** from the second protruding part **250** is applied at the second hook **260**.

(35) On the other hand, a reaction force applied at the first hook **240** and the first protruding part **230** acts in a direction of separation for the first protruding part **230** and the first hook **240** as indicated by an arrow **D1** in FIG. **9**. However, since the inclined surface **231** of the first protruding part **230** faces the inside of the second housing **22** and the inclined surface **241** of the first hook **240** faces the outside of the second housing **22**, the first hook **240** is prevented from being separated from the first protruding part **230**.

(36) Specifically, as indicated by an arrow **D2** in FIG. **9**, the side surface **243** of the first hook **240** is pressed against the side wall part **211** of the first housing **21** by the stress indicated by the arrow **D1** in FIG. **9**. When a directional rotating moment indicated by an arrow **R1** in FIG. **9** is further applied at the first hook **240**, the first hook **240** is pressed against the side wall part **211** and the first

protruding part **230** of the first housing **21**. Consequently, the second housing **22** provided with the first hook **240** is prevented from separating from the first housing **21**.

(37) As illustrated in FIG. **8**, at the second hook **260**, the inclined surface **261** in contact with the second protruding part **250** opposes the side wall part **211** of the first housing **21** in the direction indicated by the arrow **DO**. On the other hand, when the first hook **240** and the first protruding part **230** are in an engaged state, the inclined surface **231** of the first protruding part **230** and the inclined surface **241** of the first hook **240** face one another in the direction indicated by the arrow **D1** in FIG. **9**, that is the direction of inclination with respect to the Z-axis direction.

(38) When the first hook **240** is attached to the first protruding part **230** or detached from the first protruding part **230**, a distal end part **242** of the first hook **240** illustrated in FIG. **9** is required to move to the Z-axis positive direction side of a distal end part **232** of the first protruding part **230**. In the embodiment, when the first hook **240** is attached to the first protruding part **230**, for example, the first hook **240** is pulled up in the direction of the arrow in FIG. **7** utilizing extension and contraction of the member (for example, resin) forming the housing **2**, and the distal end part **242** of the first hook **240** is moved to the Z-axis positive direction side of the distal end part **232** of the first protruding part **230**.

(39) As described above, the rotating device **1** according to the embodiment includes the housing **2** including the first housing **21** and the second housing **22** for engaging with the first housing **21** and the motor **3** and the one or more gears **6** accommodated in the housing **2**. The first housing **21** and the second housing **22** oppose one another in the first direction, the side wall part **221** of the second housing **22** includes the first hook **240**, and the side wall part **211** of the first housing **21** includes the first protruding part **230** for engaging with the first hook **240**. In the first direction, the surface **241** of the first hook **240** engaging with the first protruding part **230** and the surface **231** of the first protruding part **230** engaging with the first hook **240** are in contact with one another. The surface of one of the first hook **240** and the first protruding part **230** is inclined with respect to the surface of the other of the first hook **240** and the first protruding part **230**, and the surface **231** of the first protruding part **230** faces the side wall part **211** of the first housing **21**. According to this configuration, the first hook **240** is prevented from being separated from the first protruding part **230** by the inclined surface **241** included in the first engagement part and a reaction force acting on the inclined surface **241** even when an external force acts in the direction of separation for the first housing **21** and the second housing **22**. Thus, noise-reduction of the rotating device **1** including the worm **10** can be achieved.

(40) Modifications

(41) The configurations of the present embodiment have been described above, but the embodiment is not limited to these configurations. For example, a hook with a reverse tapered shape may be formed at the first housing **21**, and a protruding part with a reverse tapered shape may be formed at the second housing **22**.

(42) The reverse tapered shape is preferably formed at the engagement part easily stressed by vibration and the like near the motor **3**, for example. However, the housing **2** may include a combination of a plurality of engagement parts with a reverse tapered shape, and all of the engagement parts may be formed with a reverse tapered shape. For example, the second hook **260** and the second protruding part **250** or the third hook **270** and the third protruding part **280** may have a reverse tapered shape like the first hook **240** and the first protruding part **230**.

(43) Either the hook or the protruding part forming an engagement part may have a reverse tapered shape. In this case, for example, when only the hook is formed with a reverse tapered shape, the stress applied from the protruding part to the hook is applied in the opposite direction to the arrow **R1** illustrated in FIG. **9**, making the hook easy to separate from the protruding part. Thus, when only either the hook or the protruding part has a reverse tapered shape, preferably, only the protruding part has a reverse tapered shape.

(44) The embodiment and the modifications of the present disclosure have been described, but the

present invention is not limited to the embodiment and the modifications but can be variously modified without departing from the spirit of the present invention. Various modifications within a scope not departing from the gist are included in the technical scope of the present invention, and this is obvious to a person having skill in the art from the description of the claims.

REFERENCE SIGNS LIST

(45) **1** Rotating device, **2** Housing, **3** Motor, **4** Group of terminals, **6** Set of gears, **7** Sensor, **8** FPC, **10** Worm, **21** First housing, **22** Second housing, **29** Boss part, **31** Rotation shaft, **50** Output gear, **51** Output shaft, **61** First transmission gear, **61a** Helical gear, **61b** Gear, **62** Second transmission gear, **93** Attachment tab, **94** Coupling hole, **209** Connector part, **210**, **220** Surface part, **211**, **221** Side wall part, **212**, **222** Opening part, **215** First opposing surface, **217** Second opposing surface, **219**, **229** Extending part, **226** Third opposing surface, **228** Fourth opposing surface, **230** First protruding part, **240** First hook, **250** Second protruding part, **260** Second hook, **270** Third hook, **280** Third protruding part, **231**, **241**, **251**, **261** Inclined surface, **232**, **242** Distal end part, **243** Side surface, **291** First through hole, **292** Second through hole

Claims

1. A rotating device, comprising: a housing including a first housing and a second housing, the second housing being configured to engage with the first housing; and a motor and one or more gears accommodated in the housing, wherein the first housing and the second housing oppose one another in a first direction, a side wall part of the second housing is provided with a first hook and a second hook, a side wall part of the first housing is provided with a first protruding part configured to engage with the first hook and a second protruding part configured to engage with the second hook, an inclined surface of the first hook configured to engage with the first protruding part and an inclined surface of the first protruding part configured to engage with the first hook are in contact with one another in the first direction, the inclined surface of the first protruding part faces inside the side wall part of the first housing, the inclined surface of the first hook faces outside the side wall part of the first housing, an inclined surface of the second hook configured to engage with the second protruding part and an inclined surface of the second protruding part configured to engage with the second hook are in contact with one another in the first direction, the inclined surface of the second protruding part faces outside the side wall part of the first housing, and the inclined surface of the second hook faces inside the side wall part of the first housing.
 2. The rotating device according to claim 1, wherein an end part of the side wall part of the first housing and an end part of the side wall part of the second housing engage with one another.
 3. The rotating device according to claim 1, wherein the first hook is in contact with the side wall part of the first housing.
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