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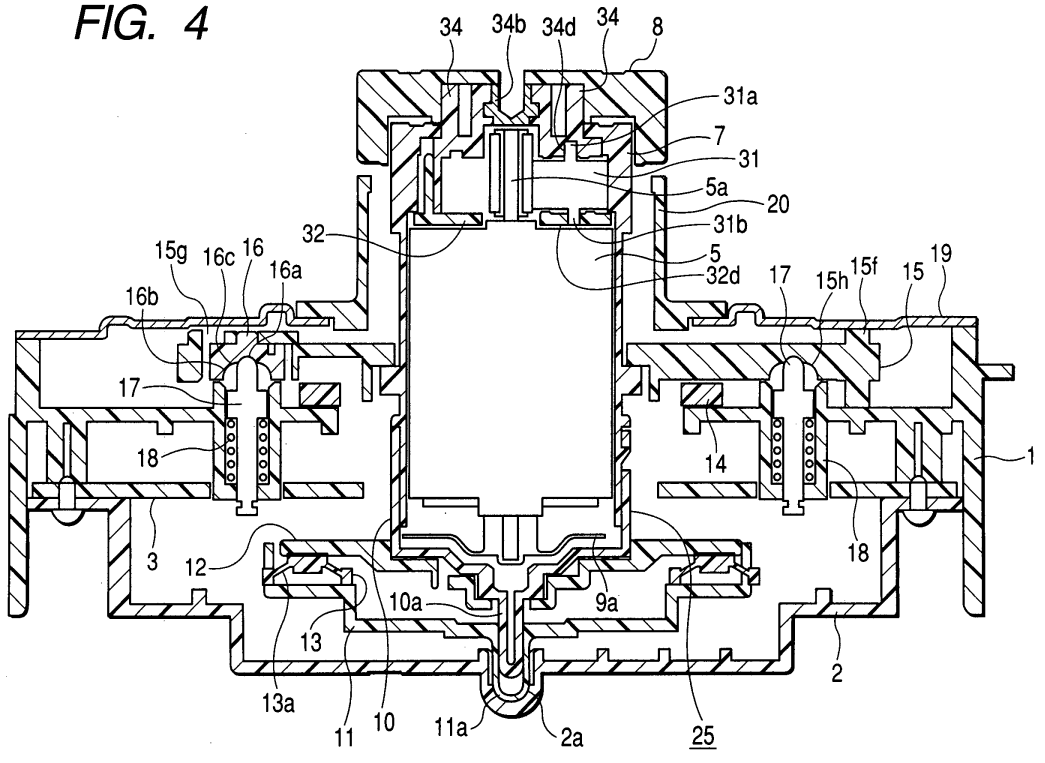
(54) Haptic feedback input device

(57) Haptic feedback input device comprising an operating section (4) that performs at least a rotation operation and a pivot operation; a motor (5) that pivots in conjunction with the pivot operation of the operating section (4) and that imparts a feedback force in accordance with the rotation operation of the operating section (4) to the operating section (4); a motor holding member (7,10,11,12) that holds the motor (5); and a housing (1,2,19,20) that pivotably supports the motor (5) via the motor holding member (7,10,11,12) whereby the motor holding member (7,10,11,12) has a protrusion (11a) that protrudes in an extension direction of a rotational shaft (5a) of the motor (5) on an opposite side to the operating section (4), and the housing (1,2,19,20) has a receiving portion (2a) that pivotably supports the motor holding member (7,10,11,12) with the protrusion (11a) mounted thereon.

FIG. 4



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a haptic feedback input device in which a motor imparts a required feedback force to an operating section at the time of a rotation operation. More particularly, the present invention relates to a haptic feedback input device in which an operating section and a motor integrally pivot at the time of a pivot operation.

2. Description of the Related Art

[0002] As an input device capable of collectively controlling various in-vehicle electrical apparatuses, such as an air conditioner, a radio, a television, a CD player, a navigation system, and the like, the inventors has proposed a haptic feedback input device shown in Fig. 6 (for example, see Japanese Unexamined Patent Application Publication No. 2002-149324). The input device shown in Fig. 6 has a housing (frame) 50 that is provided with a curved receiving portion 51 therein, a motor 52 that is pivotably housed in the housing 50, a bracket 53 that is fitted to an outer circumference of the motor 52 and is pivotably supported on the curved receiving portion 51, an operating section 54 that is fitted to a driving shaft 52a of the motor 52, a first position sensor 55 that detects a pivot direction and a pivot distance of the motor 52, a second position sensor 56 that detects a rotation direction and a rotation distance of the driving shaft 52a, and a control section (not shown) that receives position signals outputted from the first and second position sensors 55 and 56 to control driving of the motor 52. In such a haptic feedback input device, the motor 52 imparts a required feedback force to the operation section 54 at the time of a rotation operation based on a control signal of the control section.

[0003] In the related art haptic feedback input device described above, the motor 52 is supported on the curved receiving portion 51 of the housing 50 via the bracket 53. Accordingly, the pivot center of the operating section 54 becomes a point O shown in Fig. 6 and thus a pivot radius tends be small. For this reason, in order to obtain a required pivot distance at the time of a pivot operation, it is necessary to considerably incline the operating section 54. However, in order to realize the configuration in which the operating section 54 can be considerably inclined, a wide gap C must be ensured between the operating section 54 and the upper surface of the housing 50 so as to prevent both of them from contacting each other. Accordingly, in such a related art haptic feedback input device, foreign substances, such as dust particles or the like, may enter the housing 50 from the gap C, which causes an erroneous operation. Further, the gap C is easily noticed from the outside, and thus such a structure having the gap C is not preferable in appearance. In addition, the operating section 54 cannot move in an approximately horizontal direction at the time of the pivot operation, and thus operation quality is not favorable. Therefore, there is much room for improvement.

SUMMARY OF THE INVENTION

[0004] The invention has been made in consideration of the above-described problems of the related art, and it is an object of the invention to provide a haptic feedback input device that causes an operating section to move in an approximately horizontal direction at the time of a pivot operation so as to increase operation quality and suppresses foreign substances, such as dust particles or the like, from entering, without damaging the appearance thereof.

[0005] In order to achieve the above-described object, according to an aspect of the invention, a haptic feedback input device includes an operating section that performs at least a rotation operation and a pivot operation, a motor that pivots in conjunction with the pivot operation of the operating section and that imparts a required feedback force in conjunction with the rotation operation of the operating section to the operating section, a motor holding member that holds the motor, and a housing that pivotably supports the motor via the motor holding member. The motor holding member has a protrusion that protrudes in an extension direction of a rotational shaft of the motor on an opposite side to the operating section, and the housing has a receiving portion that pivotably supports the motor holding member with the protrusion mounted thereon.

[0006] In the haptic feedback input device constituted in such a manner, a front end of the protrusion provided in the motor holding member becomes a pivot point, and thus a pivot radius of the operating section can be made large. Therefore, the operating section can move in an approximately horizontal direction at the time of the pivot operation, thereby increasing operation quality. Further, a wide gap does not need be ensured between the operating section and the housing in order to prevent both of them from contacting each other, and thus foreign substances, such as dust particles or the like, can be prevented from entering, without damaging the appearance thereof.

[0007] In the haptic feedback input device according to the aspect of the invention, it is preferable that the receiving portion protrudes from an outer bottom surface of the housing, such that the protrusion is inserted into a concave portion in an inner bottom surface of the receiving portion. By doing so, a bottom portion of the housing can be made compact and thus the entire device can be reduced in size. Further, with the receiving portion protruding from the outer bottom surface, the pivot radius can be made large.

[0008] Further, in the haptic feedback input device according to the aspect of the invention, it is preferable that

an elastic mat member having a diameter larger than that of the protrusion is installed on the inner bottom surface of the receiving portion, such that the protrusion is mounted on the elastic mat member. By doing so, even when the front end of the protrusion is deviated from a center line of the receiving portion, the protrusion is supported in a stable posture on the elastic mat member while pressing and bending the elastic mat member. Therefore, an inclination at an intermediate position of the operating section and the motor due to a positional deviation of the motor holding member and the housing can be surely prevented from occurring. That is, even when the pivot point is not aligned with the center line of the housing, the motor holding member is pivotably supported in a stable posture by the elastic mat member. Therefore, an assembling position of the motor holding member on the housing does not need be defined with high precision, thereby markedly enhancing assembling characteristics. As a result, the operating section or the motor can be easily and surely assembled in a desired posture.

[0009] Further, in the haptic feedback input device according to the aspect of the invention, it is preferable that the motor holding member has a first holding section that is fitted to the motor, a second holding section that has the protrusion, and a snap restoring unit that is interposed and elastically buckled between the first holding section and the second holding section. In this case, the operating section may be pressed in a shaft direction of the rotational shaft such that the first holding section buckles the snap restoring unit. By doing so, position signals can be extracted from a press operation (push operation) of the operating section, as well as the rotation operation and the pivot operation. Therefore, a multi-functional device can be implemented. Further, a click feeling caused by buckling of the snap restoring unit at the time of the press operation is transmitted to the operating section, thereby obtaining a favorable operation feeling.

[0010] In this case, the snap restoring unit may be constituted by a ring-shaped rubber spring in which a plurality of dome portions protrude in a circumferential direction. Further, the rubber spring may have an outer diameter larger than that of the motor. If doing so, when the number of dome portions is increased, durability of the rubber spring can be easily increased.

[0011] Further, in the haptic feedback input device according to the aspect of the invention, it is preferable that a guide protrusion protrudes from an outer bottom surface of the first holding section and extends along the rotational shaft of the motor. In this case, the protrusion of the second holding section may be hollow, such that the guide protrusion is slidably fitted into the hollow portion. By doing so, the guide protrusion can smoothly ascend and descend while being guided along an inner wall surface of the protrusion (the circumferential wall of the hollow portion) at the time of the press operation. Further, the guide protrusion and the protrusion are held to be engaged with each other at the time of the pivot operation, and thus the motor holding member can be inclined as a single body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 is an exploded perspective view of a haptic feedback input device according to a first embodiment of the invention;

Fig. 2 is an exploded perspective view of a planetary gear mechanism included in the haptic feedback input device according to the first embodiment;

Fig. 3 is a plan view of a cam member included in the haptic feedback input device according to the first embodiment;

Fig. 4 is a cross-sectional view of the haptic feedback input device according to the first embodiment;

Fig. 5 is a cross-sectional view of a haptic feedback input device according to a second embodiment of the invention; and

Fig. 6 is a cross-sectional view of a haptic feedback input device according to the related art.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] Hereinafter, embodiments of the invention will be described with reference to the drawings. Fig. 1 is an exploded perspective view of a haptic feedback input device according to a first embodiment of the invention. Fig. 2 is an exploded perspective view of a planetary gear mechanism included in the haptic feedback input device according to the first embodiment. Fig. 3 is a plan view of a cam member included in the haptic feedback input device according to the first embodiment. Fig. 4 is a cross-sectional view of the haptic feedback input device according to the first embodiment.

[0014] As shown in Figs. 1 and 4, the haptic feedback input device according to the present embodiment schematically includes a case 1, a base 2 that has a receiving portion 2a protruding downwardly and is attached to a lower portion of the case 1, a printed wiring board 3 on which various circuit components are mounted, an operating section 4 that is manually operated by a user, a motor 5 that imparts a required feedback force to the operating section 4, a planetary gear mechanism 6 that is disposed between the operating section 4 and the motor 5, a motor holder 7 that surrounds and holds the motor 5 and the planetary gear mechanism 6, a fitting member 8 that is fitted to the planetary gear mechanism 6 and is enclosed by the operating section 4, an encoder 9 that detects a rotation direction and a rotation distance of a rotational shaft 5a of the motor 5, an encoder holder 10 that is fitted to the motor holder 7 to hold the encoder 9, a pivot holder 11 that has a protrusion 11a being inserted into the receiving portion 2 a and is pivotably supported on the base 2, a rubber pusher 12 that receives a press operation force of the operating section 4 via the encoder holder 10, a rubber spring 13 that is interposed between

the rubber pusher 12 and the pivot holder 11, a lower slider 14 that slides in a single direction on an upper surface plate 1a of the case 1, an upper slider 15 that slides along the upper surface plate 1a in conjunction with a pivot operation of the motor holder 7, a cam member 16 that is fitted to a lower surface of the upper slider 15, a pair of driving rods 17 that are set to be freely inserted into the upper surface plate 1a of the case 1 and come into elastic contact with cam surfaces, such as the cam member 16 or the like, springs 18 that elastically bias the driving rods 17 upward, a cover member 19 that is fitted to the case 1 so as to cover the upper surface plate 1a, an extension cover 20 that is fitted onto the cover member 19 at a position to surround an upper portion of the motor holder 7, a driving body 22 that pressibly drives a rubber contact member 21 mounted on the printed wiring board 3, and a photo detection switch 23 that detects a change in height of the rubber pusher 12. In the haptic feedback input device, the motor 5, the planetary gear mechanism 6, the motor holder 7, the encoder 9, and the encoder holder 10 are unitized so as to constitute a motor unit 25. Further, the case 1, the base 2, the cover member 19, and the extension cover 20 are assembled with one another so as to constitute a housing. In the housing, various members, such as the motor unit 25, to which the rubber pusher 12 is fitted, the rubber spring 13, the pivot holder 11, the lower slider 14, the upper slider 15, the driving rods 17, and the like, are housed.

[0015] The case 1 is made of synthetic resin and has a box shape having the upper surface plate 1a. In a substantially central portion of the upper surface plate 1a, a center hole 1b opens, through which the motor holder 7 pivotably passes. In the upper surface plate 1a, two guide grooves 1c, which guide the lower slider 14 in the single direction, are formed on both sides with the center of the center hole 1b interposed therebetween. In addition, in the vicinity of the center hole 1b of the upper surface plate 1a, two cylindrical receiving concave portions 1d, which receive the driving rods 17 and the springs 18, and a relieving hole 1e, through which a stick portion 22b of the driving body 22 passes, are formed.

[0016] The base 2 is made of synthetic resin and has a cover shape that can be attached to the lower portion of the case 1. In a substantially central portion of the base 2, a receiving portion 2a, into which the protrusion 11a of the pivot holder 11 is inserted to be pivotably supported, is formed.

[0017] The printed wiring board 3 has a circuit pattern (not shown) that is formed on at least one of surfaces of an insulating substrate. On the surface of the printed wiring board 3, various circuit components are mounted. Fixed contacts (not shown) are formed as a part of the circuit pattern. The rubber contact member 21 is fixed at a predetermined position on the printed wiring board 3. The fixed contacts are disposed below dome-shaped contact portions 21a of the rubber contact member 21, respectively.

[0018] The operating section 4 is manually operated by a user and is made of synthetic resin. The operating section 4 is formed so as to have size and shape suitable for the manual operation. The operating section 4 integrally encloses the fitting member 8.

[0019] A rotational motor, such as a DC motor or the like, can be used as the motor 5. The motor 5 is driven and stopped according to signals from a control device (not shown) and imparts a required feedback force in conjunction with the rotation operation of the operating section 4 to the operating section 4.

[0020] The planetary gear mechanism 6 has only synthetic resin-based components. As shown in Fig. 2 in a magnified scale, the planetary gear mechanism 6 includes a sun gear 30 that is fixed to the rotational shaft 5a of the motor 5, three planetary gears 31 that are engaged with the sun gear 30 and revolve around the sun gear 30, a regulating member 32 that regulates the movements of the respective planetary gears 31 in the shaft direction, a ring gear 33 that is formed on the inner surface of the motor holder 7 and is engaged with the planetary gears 31, a carrier 34 that axially supports the planetary gears 31 and rotates along with the operating section 4 in conjunction with the revolution of the planetary gears 31.

[0021] Each of the planetary gears 31 has substantially a cylinder shape, and rotational shafts 31a and 31b are coaxially formed at the central portions of both surfaces thereof (see Fig. 4).

[0022] As shown in Fig. 2, the regulating member 32 has a disc portion 32a and three coupling portions 32b that stand upright along a circumferential portion of the disc portion 32a. A center hole 32c through which the sun gear 30 passes is provided at the center of the disc portion 32a. Further, bearing holes 32d that axially support rotational shafts 31a of the planetary gears 31 and regulating holes 32e that regulate the rotation of the carrier 34 are provided around the center hole 32c. In addition, a long anchoring hole 32f that snap-couples with the carrier 34 is provided in each of the coupling portions 32b.

[0023] The carrier 34 has a disc portion 34a, a cylindrical shaft portion 34b that is formed on the upper surface of the disc portion 34a, and three coupling portions 34c that are formed along an outer circumferential portion of the disc portion 34a. As shown in Fig. 4, bearing holes 34d that axially supports the rotational shafts 31b of the planetary gears 31 are formed on the lower surface of the disc portion 34a. In addition, a thread hole 34e that fastens the fitting member 8 is formed at the central portion of the upper surface of the shaft portion 34b, and anchoring claws 34g that are correspondingly engaged with the anchoring holes 32f of the regulating member 32 are formed in the approximately central portions of the respective coupling portion 34c. Also, protrusions 34h that are inserted into the regulating holes 32e of the regulating member 32 protrude from the lower ends of the respective coupling portions 34c.

[0024] The regulating member 32 and the carrier 34

are snap-coupled with each other so as to integrally rotate by inserting the protrusions 34h into the regulating holes 32e and by coupling the anchoring claws 34g with the anchoring holes 32f. Further, the planetary. gears 31 are housed in a space defined by snap-coupling the regulating member 32 with the carrier 34. At this time, the rotational shafts 31a are axially supported on the bearing holes 32d, and the rotational shafts 31b are axially supported on the bearing holes 34d. Therefore, the planetary gears 31 that are engaged with the sun gear 30 and the ring gear 33 revolve along the ring gear 33 and the regulating member 32 and carrier 34 rotate in conjunction with the revolution of the planetary gears 31.

[0025] The motor holder 7 is made of synthetic resin and has a cylinder shape so as to surround and hold the motor 5 and the planetary gear mechanism 6. In the outer circumferential surface of the motor holder 7, a plurality of engaging protrusions 7b that are fitted into engaging grooves 15d of the upper slider 15 are formed.

[0026] The fitting member 8 is made of synthetic resin and has a cap shape. A bolt through hole 8a is provided at the center of the fitting member 8. The fitting member 8 is fastened to the sun gear 30 by screwing the bolt passing through the bolt through hole 8a into the thread hole 34e of the carrier 34. Next, the operating section 4 is fitted to the fitting member 8 that is fastened to the carrier 34.

[0027] The encoder 9 includes a code plate 9a that is fixed to the rotational shaft 5a of the motor 5, a photo interrupter 9b that has light-emitting elements and light-receiving elements disposed on the front and rear surfaces of the code plate 9 with the code plate 9a interposed therebetween, a wiring board 9c on which the photo interrupter 9b and required circuit components are mounted, and a bracket 9d that fixes the photo interrupter 9b or the wiring board 9c to the motor 5. The photo detection switch 23 is mounted on a lower end of the wiring board 9c. The encoder 9 counts the number of codes of the code plate 9a, which pass through the photo interrupter 9b, so as to detect the rotation direction and the rotation distance of the rotational shaft 5a of the motor 5.

[0028] The encoder holder 10 is made of synthetic resin and has a vessel shape so as to house the encoder 9. A cylindrical guide protrusion 10a protrudes from the lower surface of the encoder holder 10. The encoder holder 10 is fitted to the lower portion of the motor holder 7 through snap-coupling. The guide protrusion 10a is slidably fitted into a hollow portion of the protrusion 11a of the pivot holder 11 while passing through a center hole 12a of the rubber pusher 12. Moreover, the motor holder 7 and the encoder holder 10 constitute a first holding section of the invention.

[0029] The pivot holder 11 is made of synthetic resin and has a dish shape. The hollow and cylindrical protrusion 11a having a front end of a spherical surface is formed so as to protrude from the center of the lower surface of the pivot holder 11. As described above, the protrusion 11a is inserted into the receiving portion 2a of the base 2 and the front end thereof pivotably comes in contact with the spherical surface formed in the bottom surface of the receiving portion 2a. The guide protrusion 10a of the encoder holder 10 is slidably fitted into the hollow portion of the protrusion 11a. Moreover, the spherical surface in the receiving portion 2a is formed to have a diameter larger than that of the spherical surface of the front end of the protrusion 11a. Therefore, a gap exists in the vicinity of the protrusion 11a, and thus the protrusion 11a is pivotably disposed in the receiving portion 2a. In the upper surface of the pivot holder 11, a ring-shaped flat portion 11b on which the rubber spring 13 is disposed is formed. Further, a light-shielding member 11c is provided inside the ring-shaped flat portion 11b. When the rubber pusher 12 descends to a predetermined position, the photo detection switch 23 mounted on the wiring board 9c detects the light-shielding member 11c so as to detect the press operation of the operating section 4. The pivot holder 11 on which the rubber pusher 12, the encoder holder 10, the motor holder 7, the motor 5, the planetary gear mechanism 6, and the like are mounted via the rubber spring 13, is pivotably supported by the inner bottom surface of the receiving portion 2a of the base 2. Moreover, the motor holding member of the invention is constituted by the pivot holder 11, the rubber pusher 12, the encoder holder 10, and the motor holder 7. Further, the pivot holder 11 constitutes a second holding section of the invention.

[0030] The rubber pusher 12 is made of synthetic resin and has a disc shape that can be housed in the pivot holder 11. A center hole 12a is provided at the central portion of the rubber pusher 12. The rubber pusher 12 is integrally fitted to the lower portion of the encoder holder 10 in a state in which the guide protrusion 10a of the encoder holder 10 passes through the center hole 12a.

[0031] The rubber spring 13 is made of silicon rubber having superior elasticity or the like and has a ring shape. A plurality of dome portions 13a are formed on the upper surface of the rubber spring 13 at the same pitch. The dome portions 13a can be elastically buckled. If a predetermined press force is applied from the above, the respective dome portions 13a are buckled. Then, if the press force is removed, the respective dome portions 13a return to the original states with elasticity thereof. The rubber spring 13 is interposed between the pivot holder 11 and the rubber pusher 12.

[0032] The lower slider 14 is made of synthetic resin having superior slidability and has a substantially elliptical shape. First guide protrusions 14a, which are slidably fitted into the guide grooves 1c of the case 1, protrude from the lower surface of the lower slider 14. Second guide protrusions 14b, which are slidably fitted into guide grooves 15e of the upper slider 15, protrude from the upper surface of the lower slider 14. The first guide protrusions 14a are formed so as to slide in a direction perpendicular to the slide directions of the second guide protrusions 14b. The lower slider 14 is mounted on the upper surface plate 1a of the case 1 so as to slide in conjunction

with the upper slider 15. Here, since the first guide protrusions 14a are engaged with the guide grooves 1c of the upper surface plate 1a, the lower slider 14 slides only in a single direction along the guide grooves 1c.

[0033] The upper slider 15 is made of synthetic resin having superior slidability. The upper slider 15 has a ring portion 15a, four arm portions 15b that radially protrude from four places of the ring portion 15a at constant intervals to the outside, and four contact portions 15c that radially protrude from four places corresponding to the arm portions 15b of the ring portion 15a. The contact portions 15c can come into contact with the outer circumferential surface of the motor holder 7. In the lower surface of the contact portions 15c, engaging grooves 15d, into which the engaging protrusions 7b of the motor holder 7 are fitted, are formed. The guide grooves 15e, into which the second guide protrusions 14b of the lower slider 14 are fitted, are formed in the lower surface of the ring portion 15a. Further, supporting protrusions 15f, which come into contact with the lower surface of the cover member 19 and the upper surface plate 1a of the case 1, are formed on the upper and lower surfaces of each of the arm portions 15b. In addition, a housing potion 15g for the cam member 16 is formed on the lower surface of one of the arm portions 15b, which protrude to be opposite to each other. A cam portion 15h having the same cam surface as that of the cam member 16 is formed on the lower surface of the other arm portion 15b. Further, in the upper slider 15, a driving hole 15i, in which the stick portion 22b of the driving body 22 is inserted to be driven, is formed to face the releasing hole 1e formed in the upper surface plate 1a of the case 1. The upper slider 15 is externally mounted on the motor holder 7 by fitting the engaging protrusions 7b into the engaging grooves 15d. The upper slider 15 slides along the upper surface plate 1a of the case 1 in conjunction with the pivot operation of the motor holder 7. Moreover, when the upper slider 15 slides in the extension direction of each of the guide grooves 15e, the lower slider 14 does not slide. On the other hand, if the upper slider 15 slides in another direction, the lower slider 14 slides in conjunction with the upper slider 15. When the slide direction of the upper slider 15 is perpendicular to the guide grooves 15e (in the extension direction of each of the guide grooves 1c), both sliders 14 and 15 integrally slide.

[0034] The cam member 16 is made of synthetic resin having superior slidability and wear resistance and having a petaloid cam surface on the lower surface thereof. As shown in Figs. 3 and 4, the petaloid cam surface is provided with a cam groove, in which eight circumferential concave portions 16b surround a central concave portion 16a, and convex portions 16c that are formed at the boundaries of the cam groove. The upper end of the driving rod 17 is engaged with the cam groove. Since the cam member 16 is housed in the housing portion 15g of the upper slider 15, if the upper slider 15 slides in conjunction with the pivot operation of the motor holder 7, the position of the cam member 16 with respect to the driving rod 17 changes, and thus the upper end of the driving rod 17 runs over the convex portion 16c from the central concave portion 16a and enters any one circumferential concave portion 16b. Moreover, as described above, the cam surface of the cam portion 15h of the upper slider 15 has a petaloid shape, like the cam member 16.

[0035] The driving rod 17 is made of synthetic resin having superior slidability and wear resistance, and has a rod shape. A spring receiver 17a, which stops an upper end of the spring 18, is formed in an outer circumferential portion thereof. In a state in which the motor holder 7 does not pivot, the driving rod 17 enters and comes into elastic contact with the central concave portion 16a of the cam member 16 and the central concave portion of the cam portion 15h of the upper slider 15.

[0036] The spring 18 is a coil spring which constantly biases the driving rod 17 in a single direction. The spring 18 and the driving rod 17 are housed in the housing concave portion 1d formed on the upper surface plate 1a of the case 1. The driving rod 17 comes into elastic contact with the cam member 16 or the cam portion 15h of the upper slider 15 by an elastic force of the spring 18.

[0037] The cover member 19 is made of a metal plate and is fixed to the upper end of the case 1 by screws. The cover member 19 prevents the lower slider 14, the upper slider 15, the driving rod 17, and the spring 18 from being separated and regulates the fitting height of the upper slider 15 with respect to the upper surface plate 1a of the case 1.

[0038] The extension cover 20 is made of synthetic resin. The extension cover 20 has a disc-shaped fixing portion 20a and a cylindrical cover portion 20b, which stands upright on the inner circumference of the fixing portion 20a. The extension cover 20 is fitted at the position to surround the upper portion of the motor holder 7 by screwing the fixing portion 20a to the inner circumferential portion of the cover member 19.

[0039] The rubber contact member 21 is made of silicon rubber having superior elasticity or the like. In the rubber contact member 21, four dome-shaped contact portions 21a, which respectively have movable contacts (not shown) on the zenith surfaces thereof, protrude from the surface of the rubber contact member 21. The respective contact portions 21a are selectively pressed by a disc portion 22a of the driving body 22 to be elastically buckled. The rubber contact member 21 is fixed onto the printed wiring board 3 by means of an appropriate means, and the movable contacts of the respective dome-shaped contact portions 21a face and can be brought into or out of contact with the fixed contacts of the printed wiring board 3.

[0040] The driving body 22 is made of synthetic resin and has the disc portion 22a mounted on the four dome-shaped contact portions 21a and the stick portion 22b that protrudes from the center of the disc portion 22a upward. The stick portion 22b passes through the releasing hole 1e of the upper surface plate 1a of the case 1

and is inserted into the driving hole 15i of the upper slider 15. If the upper slider 15 slides in conjunction with the upper surface plate 1a, the stick portion 22b is driven along the circumferential wall of the driving hole 15i and is inclined in the slide direction. Therefore, the disc portion 22a presses and buckles one or two dome-shaped contact portions 21a in that direction. That is, according to the slide direction of the upper slider 15 corresponding to the direction of the pivot operation of the operating section 4, the disc portion 22a selectively presses the four dome-shaped contact portions 21a, and thus the movable contact in the buckled dome-shaped contact portion 21a can be allowed to contact the underlying fixed contact. Therefore, the direction of the pivot operation can be detected by the driving body 22 and the rubber contact member 21.

[0041] In the haptic feedback input device constituted in such a manner, the rotation direction and the rotation distance of the operating section 4 are detected by the encoder 9 at the time of the rotation operation of the operating section 4, and the direction of the pivot operation of the operating section 4 is detected by the driving body 22 and the rubber contact member 21 at the time of the pivot operation of the operating section 4. Further, the press operation (push operation) of the operating section 4 is detected by the photo detection switch 23.

[0042] The operation of such a haptic feedback input device will now be described in detail. First, when the haptic feedback input device is not in'operation, the motor unit 25 that is pivotably supported onto the receiving portion 2a of the base 2 via the pivot holder 11 is held vertically with respect to the case 1 and the base 2, as shown in Fig. 4. At this time, the front ends of the driving rods 17 come into elastic contact with the central concave portion 16a of the cam member 16 or the central concave portion of the cam portion 15h. Further, when the haptic feedback input device is not in operation, since the dome portions 13a of the rubber spring 13 are not buckled, the motor unit 25 is pushed up to an initial position shown in Fig. 4 via the rubber pusher 12.

[0043] When the operating section 4 comes into the pivot operation from the above-described state by a user, the motor unit 25 pivots in the operation direction with the front end of the protrusion 11a of the pivot holder 11 as the pivot point, and the upper slider 15 and the lower slider 14 (or only the upper slider 15) slides along the upper surface plate 1a of the case 1 accordingly. Then, the relative positions of the cam member 16 and the cam portion 15h, and the driving rod 17 change. Next, the front end of the driving rod 17 runs over the convex portion 16c of the cam member 16 and the convex portion of the cam portion 15h and enters the circumferential concave portion 16b and the circumferential concave portion. Therefore, the change in elastic force of the spring 18 acting on the driving rod 17 as the click feeling is transmitted to the user and the user can feel the distance of the pivot operation by a finger. Further, in such a manner, when the motor unit 25 pivots integrally with the operating section 4 or the pivot holder 11 by a predetermine distance, the upper slider 15, which slides in the direction of the pivot operation, inclines the stick portion 22b of the driving body 22, and the disc portion 22a selectively buckles the dome-shaped contact portions 21a. Therefore, the movable contact in the buckled dome-shaped contact portion 21a can come in contact with the underlying fixed contact so as to detect the direction of the pivot operation, and the detection signal is outputted to a control device (not shown). For this reason, for example, an in-vehicle electrical apparatus can be selected by the control device according to the direction of the pivot operation. Further, the user removes the operation force acting on the operating section 4, the driving rod 17 automatically returns to the central concave portion 16a of the cam member 16 or the central concave portion of the cam portion 15h by the elastic force of the spring 18. Then, the motor unit 25 returns to the state in which the motor unit 25 is held vertically with respect to the case 1 and the base 2, and the operating section 4, the pivot holder 11, the upper slider 15, or the like automatically returns to the initial state shown in Fig. 4. Further, the buckled dome-shaped contact portion 21a returns to the original shape with its elasticity, such that the movable contact and the fixed contact are separated from each other.

[0044] Next, the operation at the time of the rotation operation will be described. When the operating section 4 comes into the rotation operation by the user, the rotational shaft 5a of the motor 5 rotates via the fitting member 8 and the planetary gear mechanism 6. The rotation direction and the rotation distance of the rotational shaft 5a are detected by the encoder 9 and are outputted to the control device. For this reason, for example, the function of the in-vehicle electrical device can be adjusted by the control device according to the direction of the rotation operation. Further, since the control device can control driving and stopping of the motor 5 according to output signals from the encoder 9, the rotational force of the motor 5 controlled by the control device is transmitted to the operating section 4 via the planetary gear mechanism 6 and the fitting member 8. As a result, a feedback force according to the rotation operation state is imparted to the operating section 4. At this time, the operating section 4 is supplied with a motor output that is amplified according to the ratio of the number of teeth of the sun gear 30 and the number of teeth of the ring gear 33. Therefore, it is possible to impart a large feedback force to the operating section 4 using a small motor output.

[0045] Next, the operation at the time of the press operation will be described. When the user presses the operating section 4 downward to perform the press operation, the press force is imparted to the rubber spring 13 via the fitting member 8, the motor unit 25, or the rubber pusher 12. Then, each dome portion 13a is buckled and thus the click feeling is generated. Further, if the operating section 4 is in the press operation, the photo detection switch 23 detects the relative movement of the light-shielding member 11c and outputs the detection sig-

nal to the control device. With the control device, for example, the selected in-vehicle electrical apparatus or the selected function adjustment can be determined. At this time, the guide protrusion 10a of the encoder holder 10 is inserted into the protrusion 11a of the pivot holder 11 deeply. Further, when the user removes the press force acting on the operating section 4, each dome portion 13a of the rubber spring 13 returns to the original shape with its elasticity. Therefore, the motor unit 25, the fitting member 8, the operating section 4, or the like is pushed up to the initial position by the rubber pusher 12, and the guide protrusion 10a ascends up to the height shown in Fig. 4 in the protrusion 11a.

[0046] As such, in the haptic feedback input device according to the present embodiment, the pivot holder 11, the motor unit 25, and the operating section 4 integrally pivot with the front end of the protrusion 11a of the pivot holder 11 as the pivot point, and thus the pivot radius of the operating section 4 becomes large at the time of the pivot operation. Therefore, the operating section 4 can move in the approximately horizontal direction at the time of the pivot operation, and thus operation quality can be increased. Further, a wide gap does not need be ensured between the lower end of the operating section 4 (the lower end of the fitting member 8) and the upper end of the extension cover 20 in order to prevent both of them from contacting each other. As a result, foreign substances, such as dust particles or the like, can be prevented from entering, without damaging the appearance. Besides, in the haptic feedback input device, the receiving portion 2a, which pivotably supports the protrusion 11a of the pivot holder 11, protrudes from the outer bottom surface of the base 2, and the protrusion 11a is inserted into the concave portion on the inner bottom surface of the receiving portion 2a. Therefore, the bottom portion of the base 2 can be made compact, and thus the entire device can be reduced in size.

[0047] Further, in the haptic feedback input device according to the present embodiment, the motor holder 7 that holds the motor 5, the encoder holder 10 that is fitted to the lower portion of the motor holder 7, and the rubber pusher 12 are supported by the pivot holder 11 having the protrusion 11a via the rubber spring 13. Therefore, the positional signals can be extracted by the press operation of the operating section 4, as well as the rotation operation and the pivot operation of the operating section 4. As a result, a multi-functional device can be implemented. Moreover, the rubber spring 13, which generates the click feeling at the time of such a press operation, is made of a ring-shaped member having a diameter larger than that of the motor 5. Therefore, by providing the plurality of dome portions 13a, which can be elastically buckled, durability can be easily increased.

[0048] In the haptic feedback input device according to the present embodiment, the guide protrusion 10a provided in the encoder holder 10 is slidably inserted into the hollow portion of the protrusion 11a provided in the pivot holder 11. Therefore, the guide protrusion 10a can smoothly ascend and descend while being guided along the inner wall surface of the protrusion 11a (the circumferential wall of the hollow portion) at the time of the press operation. Further, the guide protrusion 10a and the protrusion 11a are held to be engaged with each other at the time of the pivot operation, and thus the motor unit 25 and the pivot holder 11 can be inclined as a single body. As a result, favorable operationality can be expected.

[0049] Fig. 5 is a cross-sectional view of a haptic feedback input device according to a second embodiment of the invention. The same parts as those in Figs. 1 to 4 are represented by the same reference numerals, and the descriptions thereof will be omitted.

[0050] The haptic feedback input device shown in Fig. 5 is different from the above-described haptic feedback input device of the first embodiment in that the receiving portion 2a of the base 2 is in a large concave shape, an elastic mat member 24 having a diameter sufficiently larger than that of the protrusion 11a is installed at the flat inner bottom surface of the receiving portion 2a, and the protrusion 11a is mounted on the elastic mat member 24. The elastic mat member 24 is a mat-shaped member made of urethane rubber of silicon rubber having superior elasticity, on which the protrusion 11a of the pivot holder 11 for supporting the motor unit 25 is mounted. Since the elastic mat member 24 is pressed and bent, the protrusion 11a is pivotably supported on the elastic mat member 24 in a stable posture.

[0051] In the haptic feedback input device constituted in such a manner, even when the front end of the protrusion 11a is deviated from the center line of the receiving portion 2a, since the protrusion 11a is supported in a stable posture on the elastic mat member 24 while pressing and bending the elastic mat member 24, the inclination at the intermediate position of the operating section 4 and the motor 5 due to the deviation in the assembling position can be surely prevented from occurring. That is, even when the pivot point of the motor unit 25 is not aligned with the center line of the receiving portion 2a, the motor unit 25 is pivotably supported in the stable posture by means of the elastic mat member 24. Therefore, the assembling position of the motor unit 25 with respect to the case 1 or the base 2 does not need be defined with high precision, such that assembling characteristics can be markedly enhanced. As a result, the operating section 4 or the motor 5 can be easily and surely assembled in a desired posture.

[0052] In the haptic feedback input device of the invention, the protrusion protrudes on an opposite side to the operating section of the motor holding member, and the front end of the protrusion becomes the pivot point. Therefore, the pivot radius of the operating section can be made large at the time of the pivot operation, thereby allowing the operating section to move in the approximately horizontal direction. As a result, operation quality can be increased and the wide gap does not need be ensured between the operating section and the housing

in order to prevent both of them from contacting each other. For this reason, the foreign substances, such as the dust particles or the like, can be prevented from entering, without damaging the appearance thereof. Besides, other excellent advantages can be obtained.

Claims

1. A haptic feedback input device comprising:

an operating section (4) that performs at least a rotation operation and a pivot operation;
a motor (5) that pivots in conjunction with the pivot operation of the operating section (4) and that imparts a feedback force in accordance with the rotation operation of the operating section (4) to the operating section (4) ;
a motor holding member (7, 10, 11, 12) that holds the motor (5); and
a housing (1, 2, 19, 20) that pivotably supports the motor (5) via the motor holding member (7, 10, 11, 12);
characterized in that the motor holding member (7, 10, 11, 12) has a protrusion (11a) that protrudes in an extension direction of a rotational shaft (5a) of the motor (5) on an opposite side to the operating section (4), and the housing (1, 2, 19, 20) has a receiving portion (2a) that pivotably supports the motor holding member (7, 10, 11, 12) with the protrusion (11a) mounted thereon.

2. The haptic feedback input device according to claim 1,
characterized in that the receiving portion (2a) protrudes from an outer bottom surface of the housing (1, 2, 19, 20), such that the protrusion (11a) is inserted into a concave portion in an inner bottom surface of the receiving portion (2a).

3. The haptic feedback input device according to claim 1 or 2,
characterized in that an elastic mat member (24) having a diameter larger than that of the protrusion (11a) is installed on the inner bottom surface of the receiving portion (2a), such that the protrusion (11a) is mounted on the elastic mat member (24).

4. The haptic feedback input device according to any one of claims 1 to 3,
characterized in that the motor holding member (7, 10, 11, 12) has a first holding section (7, 10) that is fitted to the motor (5), a second holding section (11) that has the protrusion (11a), and a snap restoring unit that is interposed and elastically buckled between the first holding section (7, 10) and the second holding section (11), and
the operating section (4) is pressed in a shaft direction of the rotational shaft such that the first holding section (7, 10) buckles the snap restoring unit.

5. The haptic feedback input device according to claim 4,
characterized in that the snap restoring unit is constituted by a ring-shaped rubber spring (13) in which a plurality of dome portions (13a) protrude in a circumferential direction, and
the rubber spring (13) has an outer diameter larger than that of the motor (5).

6. The haptic feedback input device according to claim 4 or 5,
characterized in that a guide protrusion (10a) protrudes from_an outer bottom surface of the first holding section (7, 10) and extends along the rotational shaft (5a) of the motor (5), and
the protrusion (11a) of the second holding section (11) is hollow, such that the guide protrusion (10a) is slidably fitted into the hollow portion.

FIG. 1

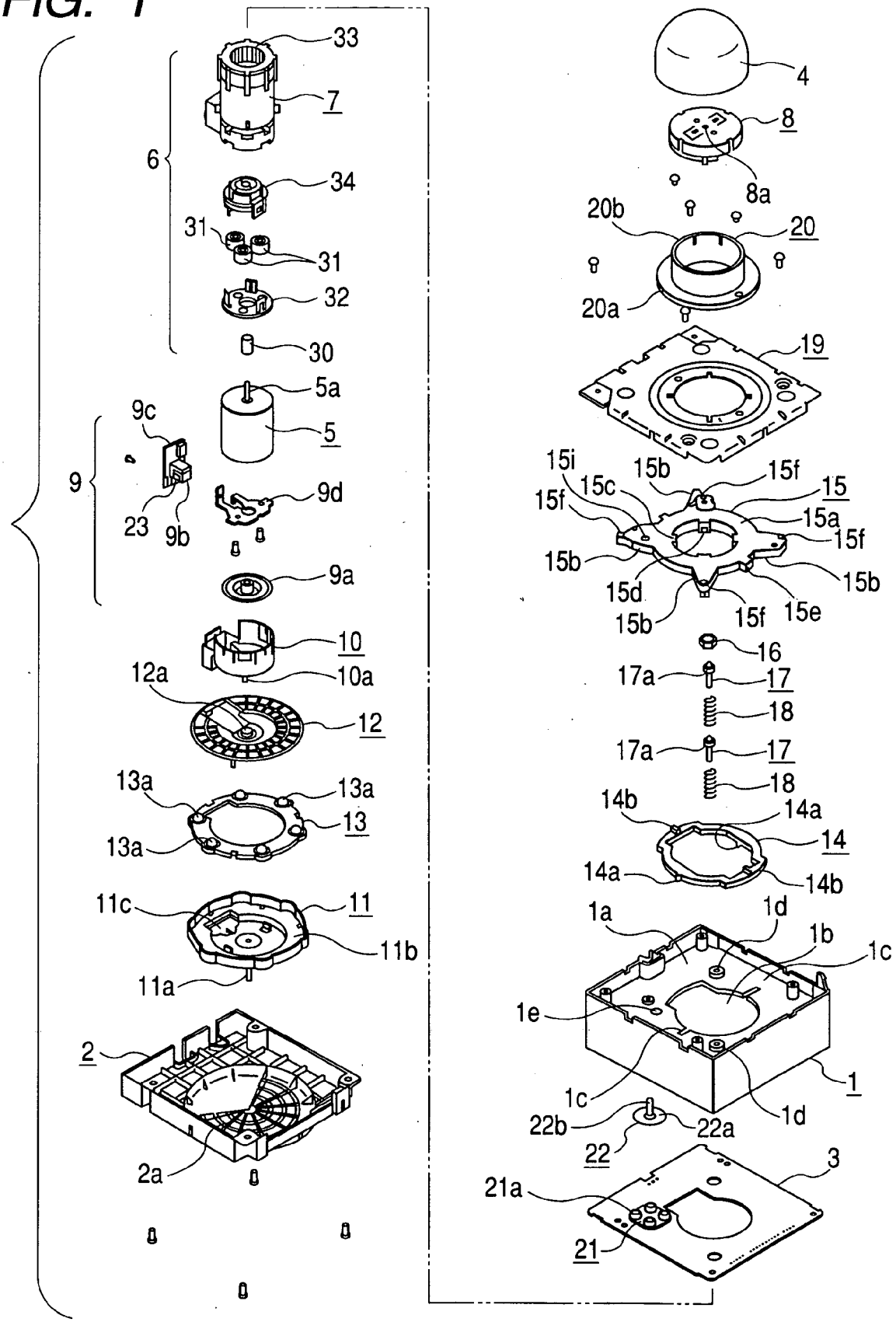
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FIG. 2

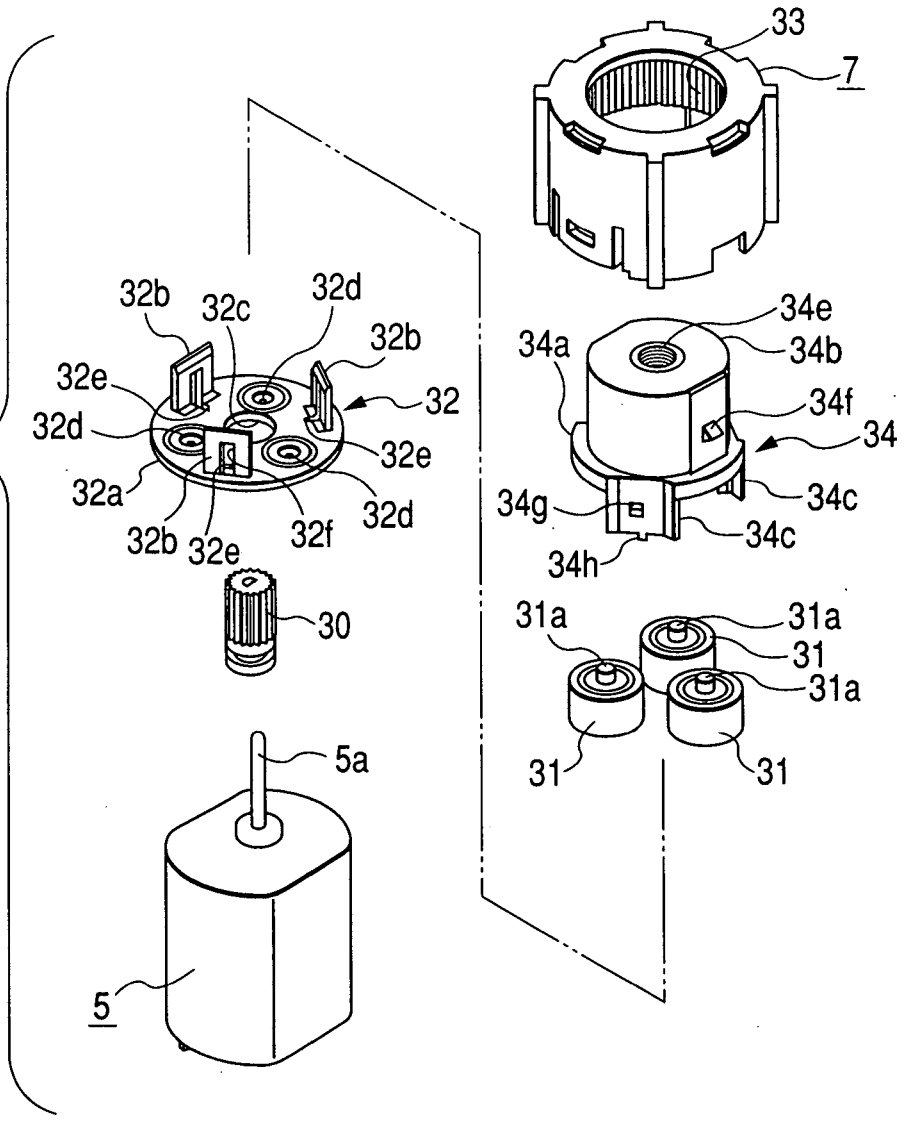
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FIG. 3

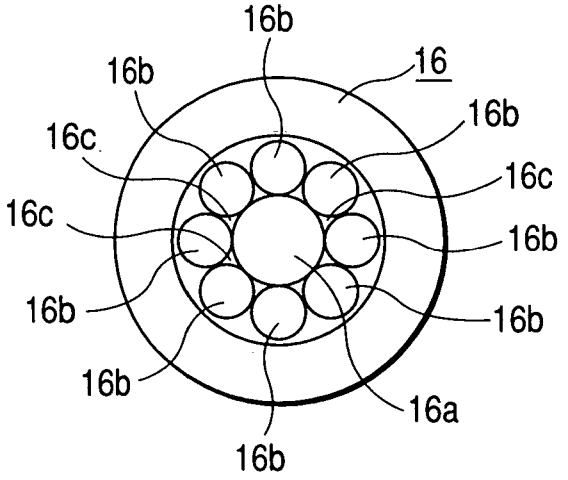
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FIG. 4

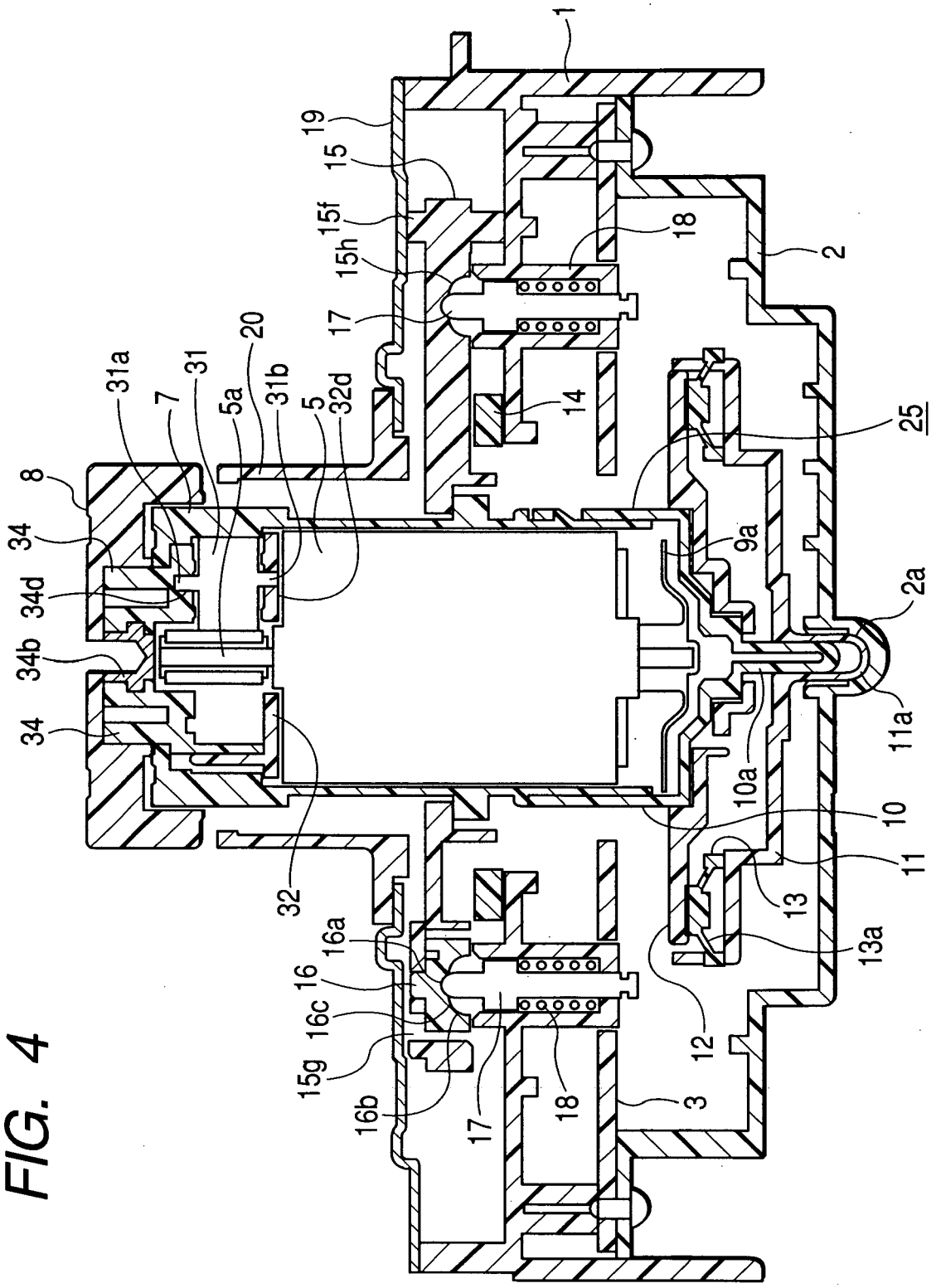
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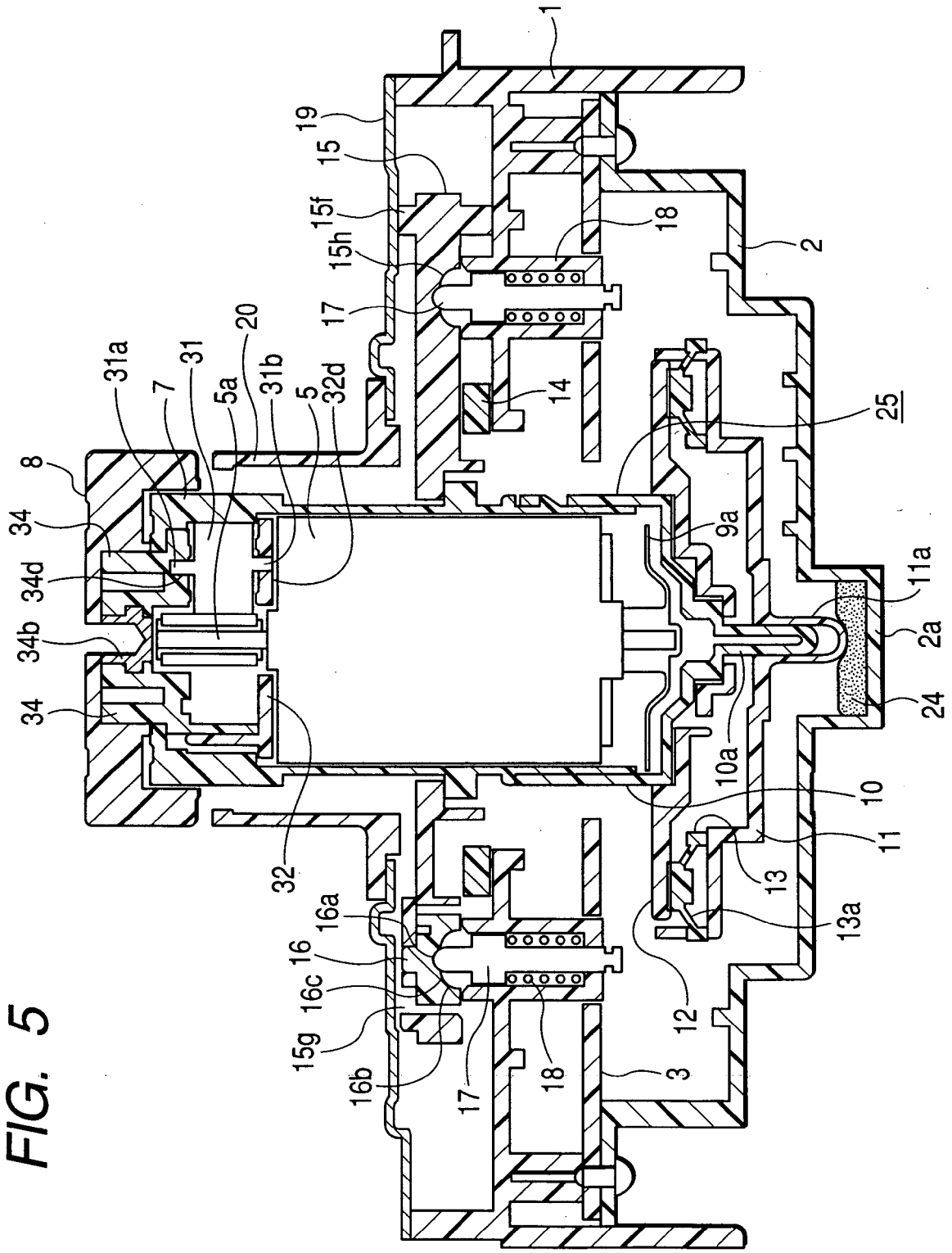
FIG. 5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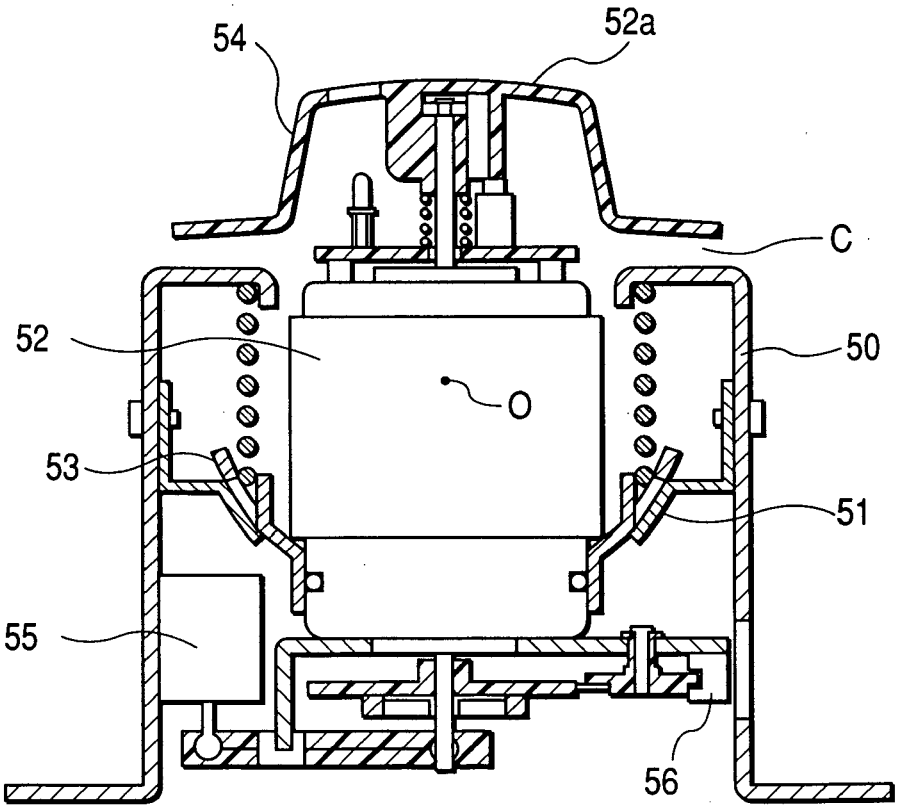
14
18
2
11a
2a
24

FIG. 6
PRIOR ART



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EUROPEAN SEARCH REPORT

Application Number
EP 05 02 1313

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	23 January 2006	Popescu, A

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