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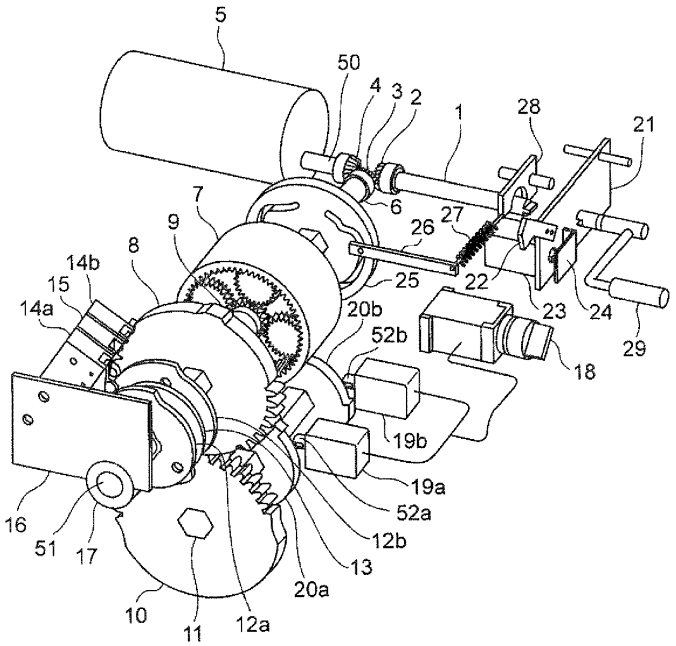
(54) Switch operating device

(57) A switch operating device has: an electric motor (5) capable of being rotated in both positive and negative directions; a drive shaft (6) rotated by the electric motor (5); a drive-side intermittent gear (8) rotated by the drive shaft (6); a driven-side intermittent gear (10) rotated by the drive-side intermittent gear (8); a main shaft (11) that is fixed to the driven-side intermittent gear (10) to drive the contacts of the switch; a disconnector lock cam (19a) and a grounding switch lock cam (19b) fixed to the main shaft (11) to be rotated; and a disconnector lock pin (52a) and a grounding switch lock pin (52b) that are capable of being engaged with and released from the disconnector lock cam (19a) and the grounding switch lock cam (19b) and capable of inhibiting predetermined range of rotation of the main shaft (11) when being engaged.

FIG.1



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Description

FIELD

[0001] The present invention relates to a switch operating device that opens/closes contacts of a switch having a three-position configuration in which a disconnector and a grounding switch have different operating angles or strokes.

BACKGROUND

[0002] In a gas insulated switchgear used in a transformation installation, a switchgear in which the main contact of a disconnector and the main contact of a working grounding switch are united for common use so as to reduce the device size is often used. In such a gas insulated switchgear, two switches (disconnector and grounding switch, etc.) are switched by one switch operating device, and a three-position switch operating device is used as the one switch operating device so as to control three main contact positions of "ON", "OFF", and "CROUND",

[0003] In view of the specification of JEC 2310-2003, etc., of Japanese Electrotechnical Committee of the Institute of Electrical Engineers of Japan, it is demanded that the interpolar insulation performance of a disconnector be 115 percent of that of a grounding switch. Under such a circumstance, an operating device in which a disconnector and a grounding switch have different operating angles or operating amounts (stroke) is demanded.

[0004] FIG. 8 illustrates a structure of a conventional switch operating device capable of controlling three positions. At "ON" operation time of a disconnector and a grounding switch, catches 40a and 40b for retaining the "OFF" position are excited by catch coils 41a or 41b and opened, allowing a roller follower 38 to move from the positions of the catches 40a or 40b.

[0005] In the case of electrical motor operation, the drive force of an electric motor 5 is input to an operation shaft 1b and then transmitted from a gear 4 to a gear 3 through a chain 43 to rotate a drive shaft 6, thus rotating a drive-side worm gear 35 coupled to the drive shaft by a key or the like. The drive force of the drive-side worm gear 35 is decelerated through a driven-side worm gear 36. The decelerated drive force then drives a main shaft 11 coupled to the driven-side worm gear 36 to rotate a main contact in a gas in an instructed direction. This allows a movable-side contact to be inserted into a disconnector fixed contact part or a grounding switch fixed contact part to establish electric conduction.

[0006] The main shaft 11 coupled to the driven-side worm gear 36 with a key rotates a plate 37 key-coupled to the main shaft 11. When the plate 37 continues being rotated, the roller follower 38 fixed on the plate 37 abuts with a stopper 39 to prevent the plate 37 from being rotated at an angle greater than an appropriate angle. Further, a limit cam 42 abuts with individually fixed limit switches 14a, 14b, 15a and 15b to turn off the power of the electric motor 5, completing the operation.

[0007] Also at "OFF" operation time, the drive force is transmitted as in the case of "ON" operation time. However, at "OFF" operation time, the roller follower 38 functions as a lock mechanism at "OFF" position to abut with the catches 40a and 40b for locking to prevent the plate 37 from being rotated at an angle greater than an appropriate angle.

[0008] In the case of manual operation, a shutter 21a or 21b is opened, and a manual handle 29 is fitted to an operation shaft 1a or 1b to rotate it. The transmission of the drive force at the drive shaft 6 and its downstream position is the same as that in the electrical motor operation. With the configuration in which the two manual operation shafts of the disconnector manual operation shaft 1a and the grounding switch manual operation shaft 1b are individually provided, any new operation is prevented from starting unless the manual handle 29 is once pulled out. For example, when the opened shutter 21a or 21b is closed to form an interlock, the shutters 21a and 21b are locked by interlock coils 23a and 23b to prevent grounding switch "ON" operation from being performed continuously immediately after disconnector "OFF" operation (refer to, e.g., Japanese Patent Application Laid-Open Publication No. 2003-208837).

[0009] As a three-position control mechanism in which the disconnector and the grounding switch have substantially the same operating angle or operating amount, there have been used a grooved cam shaft (refer to, e.g., Japanese Patent Application Laid-Open Publication No. 2005-050613), a cam plate having a recessed portion (refer to, e.g., Japanese Patent Application Laid-Open Publication No. 2003-022735), an intermittent gear (refer to, e.g., Japanese Patent Application Laid-Open Publication No. 2002-150897), a Geneva drive (refer to, e.g., Japanese Patent Application Laid-Open Publication No. 05-054747).

[0010] However, the conventional switch operating device as described above has the following problems. That is, the conventional three-position controllable switch operating device in which the disconnector and grounding switch have different operating angle or operating amount has low transmission efficiency. Accordingly, the output power of the electric motor and the device size have become larger. Further, since the catches and catch coils are used so as to make it possible for the "OFF" position to be retained / released, the configuration thereof has become complicated. Furthermore, the motor limit switches are individually provided for "ON" and "OFF" states of the disconnector and "ON" and "OFF" states of the grounding switch, so that adjustment of the positions of the limit switches with respect to the cam takes much time and trouble.

SUMMARY OF THE INVENTION

[0011] An object of the present invention is therefore

to provide a switch operating device capable of easily achieving three-point control even in the case where the disconnector and grounding switch have different operating angle or operating amount.

[0012] In order to achieve the object, according to the present invention, there is provided a switch operating device that opens/closes contacts of a switch having a three-position configuration in which a disconnector and a grounding switch have different operating angles or strokes, the device comprising: an electric motor capable of being rotated in both positive and negative directions by switching of supply power; a drive shaft rotated by the electric motor; a drive-side intermittent gear rotated by the drive shaft; a driven-side intermittent gear rotated by being meshed with the drive-side intermittent gear; a main shaft that is fixed to the driven-side intermittent gear so as to be rotated together with the driven-side intermittent gear to drive the contacts of the switch; a disconnector lock cam that is fixed to the main shaft so as to be rotated with the main shaft; a grounding switch lock cam fixed to the main shaft so as to be rotated together with the main shaft; a disconnector lock pin that is capable of being engaged with and released from the disconnector lock cam and capable of inhibiting a predetermined range of rotation of the main shaft when being engaged with the disconnector lock cam; and a grounding switch lock pin that is capable of being engaged with and released from the grounding switch lock cam and capable of inhibiting another predetermined range of rotation of the main shaft when being engaged with the grounding switch lock cam.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The above and other features and advantages of the present invention will become apparent from the discussion hereinbelow of specific, illustrative embodiments thereof presented in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view illustrating an embodiment of a switch operating device according to the present invention;

FIG. 2 is a view illustrating a drive-side intermittent gear and a driven-side intermittent gear in "OFF" state of the switch operating device of FIG. 1, as viewed from the axial direction of these gears;

FIG. 3 is a view illustrating the drive-side intermittent gear and driven-side intermittent gear in "GROUND" state of the switch operating device of FIG. 1, as viewed from the axial direction of these gears;

FIG. 4 is a view illustrating the drive-side intermittent gear and driven-side intermittent gear in "ON" state of the switch operating device of FIG. 1, as viewed from the axial direction of these gears;

FIG. 5 is a front view illustrating a shutter, a selection switch, and the like in a state where a disconnector / grounding switch shutter of the switch operating device of FIG. 1 is closed;

FIG. 6 is a front view illustrating a shutter, a selection switch, and the like in a state where a disconnector / grounding switch shutter of the switch operating device of FIG. 1 is opened

FIG. 7 is a view illustrating a sequence of a control circuit of the motor provided in the switch operating device of FIG. 1; and

FIG. 8 is a perspective view of an example of a conventional switch operating device.

DETAILED DESCRIPTION

[0014] An Embodiment of a switch operating device according to the present invention will be described below with reference to the accompanying drawings. In the following drawings, the same reference numerals are used to designate the same or similar parts as those in the conventional art of FIG. 8, and redundant descriptions thereof will be omitted.

[0015] FIG. 1 is a perspective view illustrating an embodiment of a switch operating device according to the present invention.

[0016] The electric motor 5 has a motor output shaft 50 and, as described later with reference to FIG. 7, can be rotated in both positive and negative directions by the switching of an electrical contact. A bevel gear 4 is fixed to the motor output shaft 50 and is meshed with a bevel gear 3 fixed to the drive shaft 6.

[0017] Although the rotary shaft of the manual operation shaft 1 extends on the same line as the motor output shaft 50, it is provided as an independent shaft. A bevel gear 2 is fixed to the manual operation shaft 1 and is meshed with the bevel gear 3 fixed to the drive shaft 6. The drive shaft 6 extends in the direction perpendicular to the extending direction of the motor output shaft 50 and the manual operation shaft 1.

[0018] A cam 25 having a groove is fixed to the drive shaft 6, and the groove of the cam 25 is connected to a manual handle falling-off preventing plate 28 by means of a link 26 and a spring 27.

[0019] The rotary shaft of the drive shaft 6 extends on the same line as the rotary shaft of a drive-side intermittent gear shaft 51. The rotation of the drive shaft 6 is decelerated by a planetary gear 7 to amplify the torque. The amplified torque is transmitted to the drive-side intermittent gear shaft 51.

[0020] A drive-side intermittent gear 8, a disconnector "ON" limit switch cam 12a, a grounding switch "ON" limit switch cam 12b, and a disconnector / grounding switch "OFF" limit switch cam 13 are fixed to the drive-side intermittent gear shaft 51. A part of the cross-section of the drive-side intermittent gear shaft 51 is formed into a regular hexagon. The regular hexagonal cross-section part of the drive-side intermittent gear shaft 51 penetrates regular hexagonal penetration holes formed in the rotary center of the drive-side intermittent gear 8 and the rotary center of the three limit switch cams 12a, 12b and 13,

allowing the drive-side intermittent gear 8 and three limit switch cams 12a, 12b and 13 to be rotated together with the drive-side intermittent gear shaft 51. Alternatively, the drive-side intermittent gear 8 and three limit switch cams 12a, 12b and 13 may be coupled to the drive-side intermittent gear shaft 51 by a key inserted into key grooves formed in a part of each of the circular cross-sections thereof for simultaneous rotation.

[0021] A disconnector "ON" limit switch (second motor limit switch) 14a, a grounding switch "ON" limit switch (third motor limit switch) 14b, and a disconnector / grounding switch "OFF" limit switch (first motor limit switch) 15 are arranged at positions opposite to the contact surfaces of the three limit switch cams 12a, 12b and 13, respectively. The three limit switches 14a, 14b and 15 are attached to a limit switch attachment plate 16 so as to be arranged in the extending direction of the drive-side intermittent gear shaft 51 spaced apart from one another by a predetermined distance.

[0022] The main shaft 11 extends in parallel to the drive-side intermittent gear shaft 51. A driven-side intermittent gear 10 is fixed to the main shaft 11 and is engaged with the drive-side intermittent gear 8. The main shaft 11, having a regular hexagonal cross-section, penetrates a regular hexagonal penetration hole formed in the driven-side intermittent gear 10, allowing the main shaft 11 and the driven-side intermittent gear 10 to be rotated together.

[0023] A disconnector lock cam 20a and a grounding switch lock cam 20b are also fixed to the main shaft 11. A disconnector lock pin 52a and a grounding switch lock pin 52b are arranged at positions opposite to the outer circumferential portions of the disconnector lock cam 20a and a grounding switch lock cam 20b. The lock pins 52a and 52b are linearly reciprocated by a disconnector lock coil 19a and grounding switch lock coil 19b, respectively.

[0024] When the lock coils 19a and 19b are excited to move the lock pins 52a and 52b toward the corresponding lock cams 20a and 20b, the lock pins 52a and 52b and the corresponding lock cams 20a and 20b are engaged with each other to stop the rotation of the main shaft 11 at predetermined positions.

[0025] The lock coils 19a and 19b are connected to a selector switch 18 and, thereby, device operation at the manual operation time can be switched.

[0026] The manual handle 29 can be detached from the manual operation shaft 1 and attached to the manual operation shaft 1, when the shutter 21 is opened. If the shutter 21 is closed in a state where the manual handle 29 is not attached, the manual handle 29 cannot be engaged with the manual operation shaft 1. The manual handle falling-off preventing plate 28 operates in a state where the manual handle 29 and manual operation shaft 1 are engaged with each other, thereby preventing falling-off of the manual handle 29.

[0027] How the drive-side intermittent gear 8 and driven-side intermittent gear 10 are engaged with each other will be described with reference to FIGS. 2 to 4. FIGS. 2 to 4 are views illustrating the drive-side intermittent gear 8 and driven-side intermittent gear 10 of the switch operating device of FIG. 1 as viewed from the axial direction of the gears. FIG. 2 illustrates "OFF" state, FIG. 3 illustrates "GROUND" state, and FIG. 4 illustrates "ON" state. The drive-side intermittent gear 8 has a first teeth portion 55 and a second teeth portion 56 which are formed at substantially opposite positions and a first circular arc portion 57 and a second circular arc portion 58 formed between the first and second teeth portions 55 and 56. A stopper 9 is protruded at the center of the first circular arc portion 57. The number of teeth of the first teeth portion 55 and that of the second teeth portion 56 need not be the same. For example, the number of teeth of the first teeth portion 55 may be smaller than that of the second teeth portion 56.

[0028] The driven-side intermittent gear 10 has a circular arc portion 60 along its circumference and a first recessed surface portion 61 formed at an opposite position to the circular arc portion 60. The length of the first recessed surface portion 61 is smaller than that of the second circular arc portion 58. Across the first recessed surface portion 61, a third teeth portion 62 and a fourth teeth portion 63 which are meshed respectively with the first and second teeth portions 55 and 56 of the drive-side intermittent gear 8 are formed in the driven-side intermittent gear 10. Further, a second recessed surface portion 64 is formed between the third teeth portion 62 and circular arc portion 60 of the driven-side intermittent gear 10, and a third recessed surface portion 65 is formed between the fourth teeth portion 63 and the circular arc portion 60.

[0029] In "OFF" state of FIG. 2, the second circular arc portion 58 of the drive-side intermittent gear 8 and the first recessed surface portion 61 of the driven-side intermittent gear 10 face each other. In this state, in whichever direction the drive-side intermittent gear 8 is rotated, the drive-side intermittent gear 8 is not engaged with the driven-side intermittent gear 10 while the second circular arc portion 58 faces the driven-side intermittent gear 10, and the driven-side intermittent gear 10 is not rotated.

[0030] When the drive-side intermittent gear 8 is rotated in the clockwise direction in the state of FIG. 2 to make the first teeth portion 55 of the drive-side intermittent gear 8 face the driven-side intermittent gear 10, the first teeth portion 55 of the drive-side intermittent gear 8 and the third teeth portion 62 of the driven-side intermittent gear 10 are meshed with each other to make the driven-side intermittent gear 10 be rotated in the counterclockwise direction.

[0031] When the drive-side intermittent gear 8 is further rotated in the clockwise direction, the first circular arc portion 57 faces the circular arc portion 60 of the driven-side intermittent gear 10, so that the driven-side intermittent gear 10 is not driven. When the drive-side intermittent gear 8 is further rotated in the clockwise direction, the stopper 9 is engaged with the circular arc portion 60 of the driven-side intermittent gear 10 to inhibit

further clockwise rotation of the drive-side intermittent gear 8. This state is the "GROUND" state of FIG. 3.

[0032] When the drive-side intermittent gear 8 is rotated in the counterclockwise direction in the state of FIG. 3, the driven-side intermittent gear 10 is rotated in the clockwise direction in substantially the reverse manner, the state is returned to "OFF" state of FIG. 2.

[0033] When the drive-side intermittent gear 8 is further rotated in the counterclockwise direction in the state of FIG. 2 to make the second teeth portion 56 of the drive-side intermittent gear 8 face the driven-side intermittent gear 10, the second teeth portion 56 of the drive-side intermittent gear 8 and the fourth teeth portion 63 of the driven-side intermittent gear 10 are meshed with each other to make the driven-side intermittent gear 10 be rotated in the clockwise direction.

[0034] When the drive-side intermittent gear 8 is further rotated in the counterclockwise direction, the first circular arc portion 57 faces the circular arc portion 60 of the driven-side intermittent gear 10, so that the driven-side intermittent gear 10 is not driven. When the drive-side intermittent gear 8 is further rotated in the counterclockwise direction, the stopper 9 is engaged with the circular arc portion 60 of the driven-side intermittent gear 10 to stop further rotation of the drive-side intermittent gear 8. This state is the "OFF" state of FIG. 4.

[0035] Operation of the operating device of FIG. 1 will next be described. In the operating device, the drive force of the electric motor 5 is input to the drive shaft 6 through the bevel gears 4 and 3 and decelerated by the planetary gear 7 to amplify the torque, and this amplified torque rotates the drive-side intermittent gear 8. In the intermittent area, the drive force is not transmitted to the driven-side intermittent gear 10. When the intermittent area passes away and the teeth are meshed with each other, the drive force is transmitted to the driven-side intermittent gear 10 to rotate the main shaft 11. Then, the limit switch cams 12a, 12b and 13 engaged with the main shaft 11 are rotated and the limit switches 14a, 14b and 15 are turned ON/OFF to disconnect the power of the electric motor 5, thereby completing the operation.

[0036] One of the features of the configuration according to the first embodiment is that, as illustrated in FIG. 1, the limit switches 14a, 14b and 15 of the motor are arranged on the drive shaft side.

[0037] The lock mechanisms are provided in both the disconnector and grounding switch so as to prevent overrun due to continuous operation. More specifically, in a state where electrical interlock with another device is not established, the mechanism lock coils 19a and 19b are not excited and, accordingly, not moved back. Thus, the lock coils 19a and 19b abut with the lock cams 20a and 20b, preventing any new operation from starting. In a state where electrical interlock with another device is established, continuous operation can be performed.

[0038] In conventional devices, the drive-side intermittent gear 8 continues rotation after the intermittent portion reaches the driven-side intermittent gear 10 and stops at the tooth mesh part as a stopper. However, in the present embodiment, in order to prevent overrun after the completion of "ON" operation, a protruded portion is formed as the stopper 9 in the intermittent area of the drive-side intermittent gear 8. The formation of the stopper allows the drive-side and driven-side intermittent gears to abut with each other at a point other than the teeth portion of the intermittent gear without providing additional component.

[0039] At the manual operation time, the shutter 21 is opened, and the manual handle 29 is fitted to the manual operation shaft 1 and rotated. Then, the cam 25 engaged with the drive shaft 6 is rotated to pull the link 26 along the groove formed in the cam 25. In conjunction with this operation, the spring 27 is pulled to push down the manual handle falling-off preventing plate 28, causing the manual handle falling-off preventing plate 28 to be anchored to the groove of the manual handle 29. The shape of the groove of the cam 25 is defined such that the manual handle 29 can be detached / attached after completion of the above operation.

[0040] A selection switch error operation preventing mechanism of the switch operating device according to the present embodiment will next be described with reference to FIGS. 5 and 6. FIG. 5 is a front view illustrating the shutter, selection switch, and the like in a state where the disconnector / grounding switch shutter of the switch operating device of FIG. 1 is closed. FIG. 6 is a front view illustrating the shutter, the selection switch, and the like in a state where the disconnector / grounding switch shutter of the switch operating device of FIG. 5 is opened.

[0041] A configuration of FIGS. 5 and 6 illustrates a case where one manual operation shaft is provided in an operating device having a three-position function. In the operating device having such a configuration includes a selection switch for remote control.

[0042] In FIG. 1, a shutter 21 is arranged in front of the manual operation shaft 1. The shutter 21 can be moved up to a position at which the manual operation handle 29 can be fitted to the manual operation shaft 1 when the interlock condition is met. The interlock coil 23 is excited only when an interlock condition is met. At normal time, the manual operation shaft 1 is hidden by a blind plate 24 so as not to be seen. Further, an error operation preventing plate 22 is attached to the shutter 21. The error operation preventing plate 22 locks a knob of the selection switch when the shutter 21 is opened to a position at which the manual handle 29 is inserted so as not to allow the selection switch 18 to be operated.

[0043] In FIG. 5, when the interlock condition is met, the interlock coil 23 is excited, and the pin of the interlock coil 23 is released from the engagement with the shutter 21 and deviates from the shutter opening / closing course. Then, the shutter 21 can be moved, and the shutter 21 is opened so as to allow the manual operation handle 29 to be inserted. The blind plate 24 is disposed such that the operation of the pin cannot be seen from the front direction and the pin cannot be touched by an operator.

[0044] Thus, by providing the error operation preventing plate 22 attached to the shutter 21, it is possible to disable the operation of the selector switch 18 at the time when the manual operation handle 29 is inserted, whichever of the three positions ("ON", "OFF" or "GROUND") the selector switch indicates.

[0045] A control circuit of the electric motor 5 provided in the switch operating device of FIG. 1 will next be described with reference to FIG. 7. FIG. 7 is a view illustrating a sequence of a control circuit of the motor provided in the switch operating device of FIG. 1.

[0046] The switch operating device is a three-position switch operating device and includes a motor control circuit having a configuration in which the rotation direction of the motor is reversed between "ON" operation and "OFF" operation.

[0047] As illustrated in FIG. 7, a positive terminal side power supply (PM) 30 is connected to the positive electrode side of the electric motor 5 through a positive rotation relay contact 321. In parallel to the power supply 30, a negative electrode side power supply (NM) 31 is connected to the positive electrode side of the electric motor 5 through a negative rotation relay contact 331. On the other hand, to the negative electrode side of the electric motor 5, the negative electrode side power supply (PM) 31 is connected through a positive rotation relay contact 322. In parallel to the negative electrode side power supply (NM) 31, the positive electrode side power supply (PM) 30 is connected to the negative electrode side of the electric motor 5 through a negative rotation relay contact 332. Further, the positive electrode side and the negative electrode side of the electric motor 5 are connected to each other through a positive rotation relay contact 32b, a negative rotation relay contact 33b, and a damping resistor 34 which are connected in series.

[0048] The positive rotation relay contacts 321 and 322 and the negative rotation relay contacts 331 and 332 are "a-contacts" (arbeit contacts) which are closed at the operation time. The positive rotation relay contact 32b and negative rotation relay contact 33b are "b-contacts" (break contacts) which are opened at the operation time.

[0049] The motor control circuit having the above circuit configuration operates as follows. At disconnector "ON" operation time, when an "ON" operation start signal is input from the outside, the terminal of the positive electrode side power supply 30 applies "ON" operation voltage, and the a-contact of the "ON" relay 321 connected between the positive electrode side power supply 30 and the electric motor 5 is closed. On the other hand, the b-cantact of the "ON" relay 32b connected between the damping resistor 34 and the negative electrode side power supply 31 is opened, and the a-cantact of the "ON" relay 322 connected between the electric motor 5 and the negative electrode side power supply 31 is closed. As a result, a circuit for "ON" operation is established, and "ON" operation for motor positive direction is performed.

[0050] After completion of the "ON" operation, the "ON" operation end limit switch 14a works with the operation of the limit switch cam 12a coupled to the main shaft 11 to disconnect the current. Thus, the contacts of the "ON" relays 321, 322 and 32b all return to the original states.

[0051] At disconnector "OFF" operation time, when an "OFF" operation start signal is input from the outside, the terminal of the positive electrode side power supply 30 applies "OFF" operation voltage, and the a-contact of the "OFF" relay 332 connected between the positive electrode side power supply 30 and the electric motor 5 is closed. On the other hand, the b-contact of the "OFF" relay 33b connected between the damping resistor 34 and the negative electrode side power supply 31 is opened, and the a-contact of the "OFF" relay 331 connected between the electric motor 5 and the negative electrode side power supply 31 is closed. As a result, a circuit for "OFF" operation is established, and motor negative rotation for "OFF" operation is performed.

[0052] After completion of the "OFF" operation, the "OFF" operation end limit switch 15 works with the operation of the limit switch cam 13 coupled to the main shaft 11 to disconnect the current, whereby the contacts of the "OFF" relays 331, 332 and 33b all return to the original states.

[0053] The control operation for the disconnector "ON" and "OFF" operations has been described above. The control operation for the grounding switch "ON" and "OFF" operations is the same as that for the disconnector "ON" and "OFF" operations, so that description thereof is omitted.

[0054] As described above, according to the present embodiment, in the case where the disconnector and the grounding switch have different operating angles, the intermittent gear and the grooved cam shaft are used as illustrated in FIG. 1 to provide the teeth portions and the cam grooves are formed by the number corresponding to the operating angle ratio between the disconnector and the grounding switch. With this configuration, it is possible to respond to the control for the three-position function having two different strokes.

[0055] Further, a configuration in which the cams 20a and 20b coupled to the main shaft 11 are locked/unlocked by the lock pins 52a and 52b each having a solenoid coil increases reliability of the lock function at the "OFF" position. Further, remote control is made possible to improve maintancibility.

[0056] Further, according to the present embodiment, the plurality of motor limit switches 14a, 14b and 15 are stacked and fixed to the limit switch attachment plate 16, and the limit switch attachment plate 16 is attached to the side surface of a bearing 17. Although the attachment plates are individually provided for adjustment of ON/OFF of the switches in the conventional approach, the above configuration allows the limit switch attachment plate 16 to perform a guide function to eliminate the need of performing assembling adjustment and need of performing adjustment in the switch push/pull direc-

tion. Thus, adjustment of ON/OFF of the limit switch can be simplified to improve assemblability.

[0057] In the conventional art, there may be a case where the motor limit switch is disposed on the driven-side. In this case, a rotation angle error occurs in the driven shaft due to backlash caused by manufacturing tolerance or assembly tolerance, so that operation speed is reduced by the loss caused by the rotation angle error, which makes it difficult to stop the rotation of the driven-side shaft with high accuracy. Thus, in order to stop the driven shaft at a desired position, a timer relay and the like need to be provided. However, according to the present embodiment, by providing the motor limit switches 14a, 14b and 15 in the drive-side shaft, it is possible to facilitate control of the stop position, thereby eliminating the need of providing the timer relay.

[0058] Further, according to the present embodiment, the handle falling-off preventing mechanism provided on the drive shaft side prevents error operation, thereby increasing reliability.

[0059] Further, according to the present embodiment, by separately providing the motor output shaft 50 and manual operation shaft 1, it is possible to facilitate attachment/detachment of the electric motor 5. While the electric motor 5 is removed, the device can be operated manually.

[0060] Further, according to the present embodiment, the use of the planetary gear 7 as a deceleration mechanism increases the drive force transmission efficiency, thereby designing the operating device more compact.

[0061] Further, according to the present embodiment, the use of the selector switch 18 allows one manual operation shaft to be selectively used for disconnector and grounding switch, which reduces the number of components required and makes the three-position switch operating device more compact.

[0062] In the case of the conventional art as illustrated in FIG. 8, two manual operation shafts for the disconnector and the grounding switch are provided and, when an operator wants to operate one device different from the other into which the manual operation handle is inserted, he or she needs to remove the manual operation handle. That is, the interlock condition of the shutter is met at this time, so that error operation can be prevented.

[0063] When only one manual operation handle is used as in the present embodiment, new operation can be started continuously from completion of a given operation while the manual operation handle is inserted. That is, the interlock of the shutter does not act. It is assumed that, after the manual handle is inserted when the selector switch indicates any one of "ON", "OFF", and "GROUND" position, the manual handle is rotated up to the intermediate position at which once the mechanism lock cam is made, and the manual operation handle is further rotated after a selection different from the content different from one indicated by the selection switch is made. In this case, a device may enter a state different from the intention of a manual operator.

[0064] For example, when the selector switch is set to the disconnector side at the grounding switch "ON" completion position, and "OFF" operation of the grounding switch is performed, the lock mechanism does not act at the "OFF" position. Accordingly, when the manual operation handle continues being rotated in this state, operation is made possible up to the disconnector "ON" completion position, which may cause major damage such as grounding fault. The same can be said to a case where the disconnector and grounding switch are reversed.

[0065] In the present embodiment, the mechanism lock functions without fail at "OFF" position to thereby prevent error operation.

Claims

1. A switch operating device that opens/closes contacts of a switch having a three-position configuration in which a disconnector and a grounding switch have different operating angles or strokes, the device comprising:

   an electric motor (5) capable of being rotated in both positive and negative directions by switching of supply power;
   a drive shaft (6) rotated by the electric motor (5);
   a drive-side intermittent gear (8) rotated by the drive shaft (6);
   a driven-side intermittent gear (10) rotated by being meshed with the drive-side intermittent gear; (8)
   a main shaft (11) that is fixed to the driven-side intermittent gear (10) so as to be rotated together with the driven-side intermittent gear (10) to drive the contacts of the switch;
   a disconnector lock cam (20a) that is fixed to the main shaft (11) so as to be rotated with the main shaft (11);
   a grounding switch lock cam (20b) fixed to the main shaft (11) so as to be rotated together with the main shaft (11);
   a disconnector lock pin (52a) that is capable of being engaged with and released from the disconnector lock cam (20a) and capable of inhibiting a predetermined range of rotation of the main shaft (11) when being engaged with the disconnector lock cam (20a); and
   a grounding switch lock pin (52b) that is capable of being engaged with and released from the grounding switch lock cam (20b) and capable of inhibiting another predetermined range of rotation of the main shaft (11) when being engaged with the grounding switch lock cam (20b).

2. The switch operating device according to claim 1, wherein
   the drive-side intermittent gear (10) is fixed to a drive-

side intermittent gear shaft (51) so as to be rotated together with the drive-side intermittent gear shaft (51),
a motor limit switch cam (12a, 12b, 13) is fixed to the drive-side intermittent gear shaft (51), and
a plurality of motor limit switches (14a, 14b, 15) that are engaged with the motor limit switch cam (12a, 12b, 13) and each outputs a signal for stopping rotation of the electric motor (5) based on rotation angle of the drive-side intermittent gear shaft (51).

3. The switch operating device according to claim 2, wherein
the motor limit switches (14a, 14b, 15) include a first motor limit switch (15) that outputs a signal in response to "OFF" state of the disconnector and the grounding switch, a second motor limit switch (14a) that outputs a signal in response to "ON" state of the disconnector, and a third motor limit switch (14b) that outputs a signal in response to "GROUND" state of the grounding switch.

4. The switch operating device according to claim 3, wherein
the first, second, and third motor limit switches (15a 14a, 14b) are arranged in an extending direction of the drive-side intermittent gear shaft (51) and are fixed to one another.

5. The switch operating device according to any one of claims 1 to 4, further comprising a planetary gear (7) that decelerates the rotation of the drive shaft (6) so as to rotate the drive-side intermittent gear shaft (51).

6. The switch operating device according to any one of claims 1 to 5, further comprising:

a manual operation shaft (1) for manually rotating the drive shaft (6) during a shutdown period of the electric motor (5);
a manual operation handle (29) for manually rotating the manual operation shaft (1) to which the manual operation shaft (1) can be attached and from which the manual operation shaft can be detached; and
a manual operation handle falling-off preventing mechanism (28) that maintains an engagement between the manual operation shaft (1) and manual operation handle (29) when they are engaged with each other.

7. The switch operating device according to any one of claims 1 to 6, further comprising:

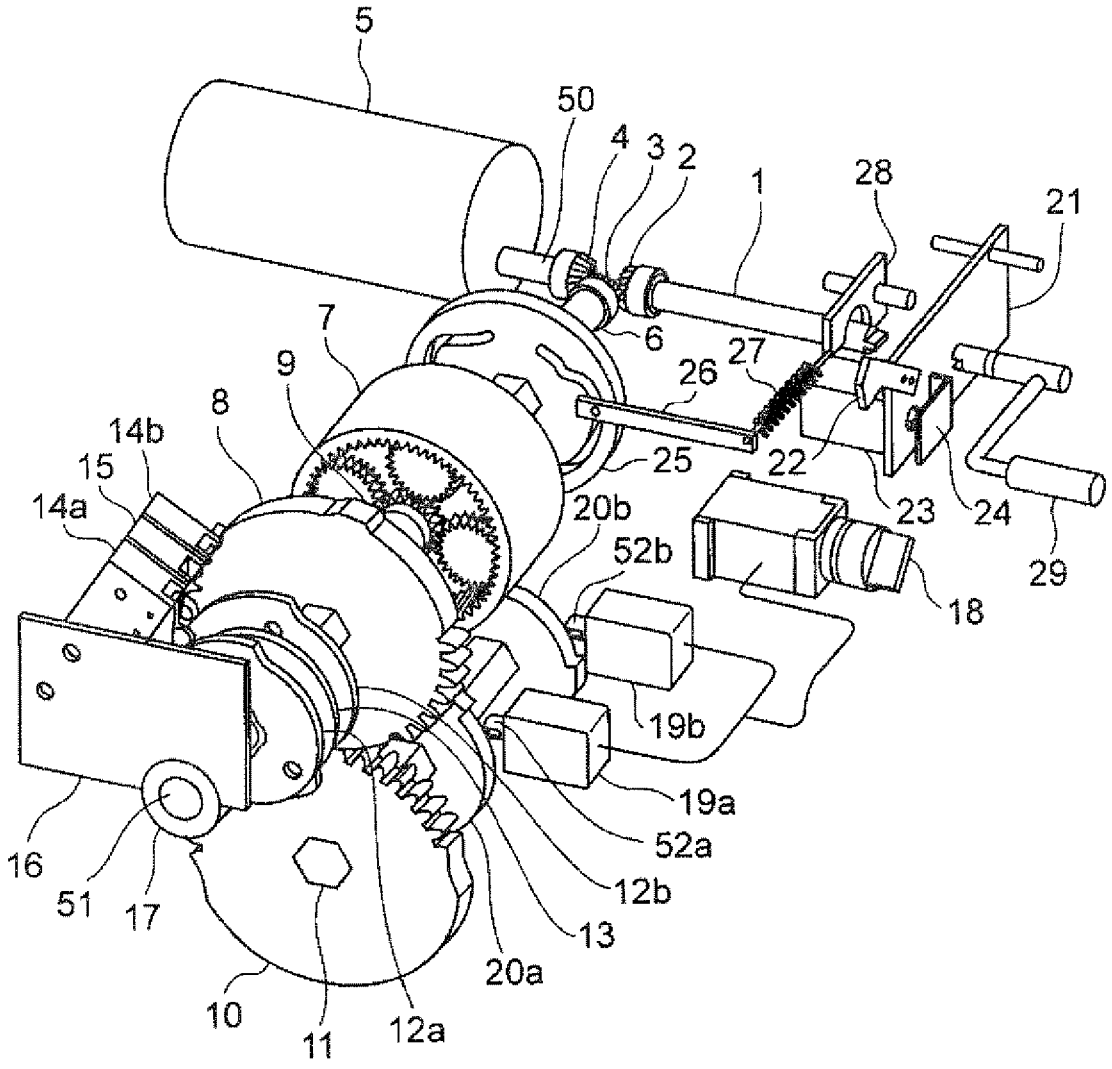
a manual operation shaft (1) for manually rotating the drive shaft (6) during the shutdown period of the electric motor (5); and
a manual operation handle (29) for manually rotating the manual operation shaft (1) to which the manual operation shaft (1) can be attached and from which the manual operation shaft (1) can be detached, wherein
the electric motor (5) has a motor shaft (50), and the drive shaft (6) is rotated by the manual operation shaft (1) or the motor shaft (50) through gears (2, 3, 4).

8. The switch operating device according to claim 6 or claim 7, further comprising:

a selector switch for switching the electric motor (5); and
a shutter (21) that is closed so as to inhibit the manual operation shaft (1) and the manual operation handle (29) from being engaged with each other under a predetermined condition when engagement between the manual operation shaft (1) and the manual operation handle (29) is released and that inhibits switching of the selector switch (18) when being opened.

9. The switch operating device according to any one of claims 1 to 8, wherein
at least one motor limit switch (15, 14a, 14b) that outputs a signal for stopping rotation of the electric motor (5) based on rotation angle of the drive-side intermittent gear shaft (51) is provided, and
the switch operating device further comprises a circuit that has a damping resistor (34) connected in parallel to the supply power and makes current flow in the damping resistor (34) by utilizing the electric motor (5) as a generator when the motor limit switch (15, 14a, 14b) is activated so as to cause the electric motor (5) to generate a damping torque.

FIG.1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20a
10
11
12a

FIG.2

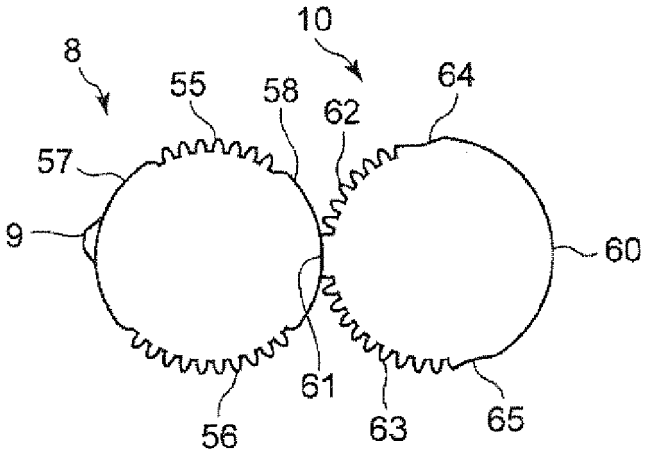

FIG.3

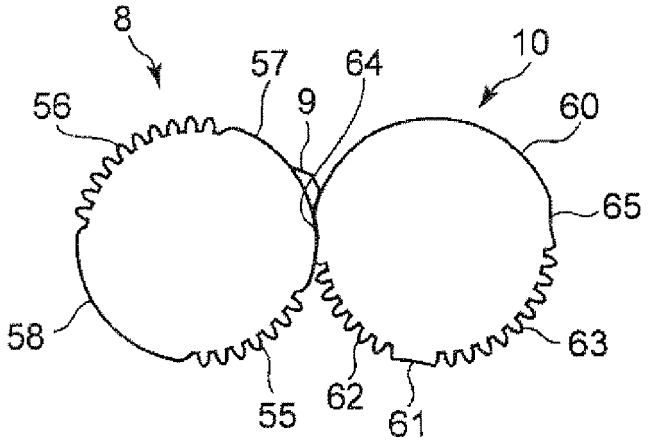

FIG.4

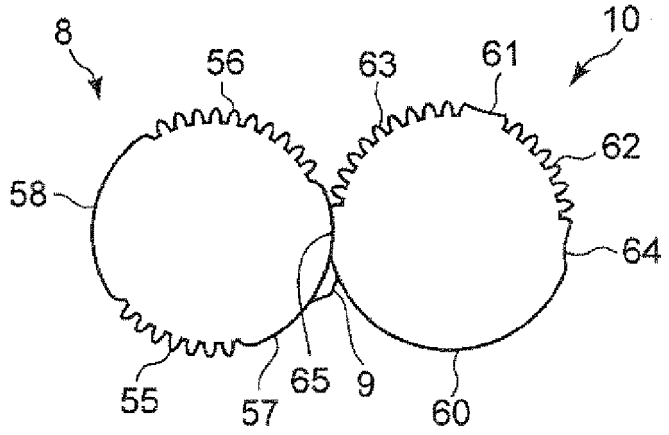

FIG.5

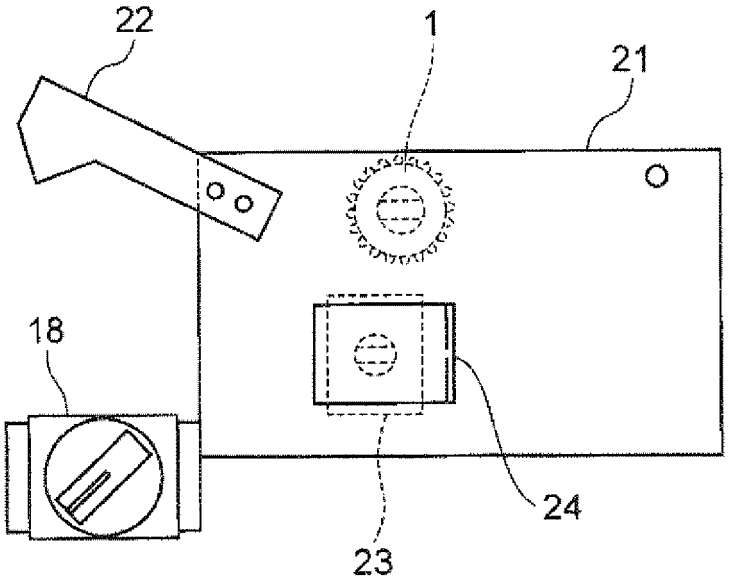

FIG.6

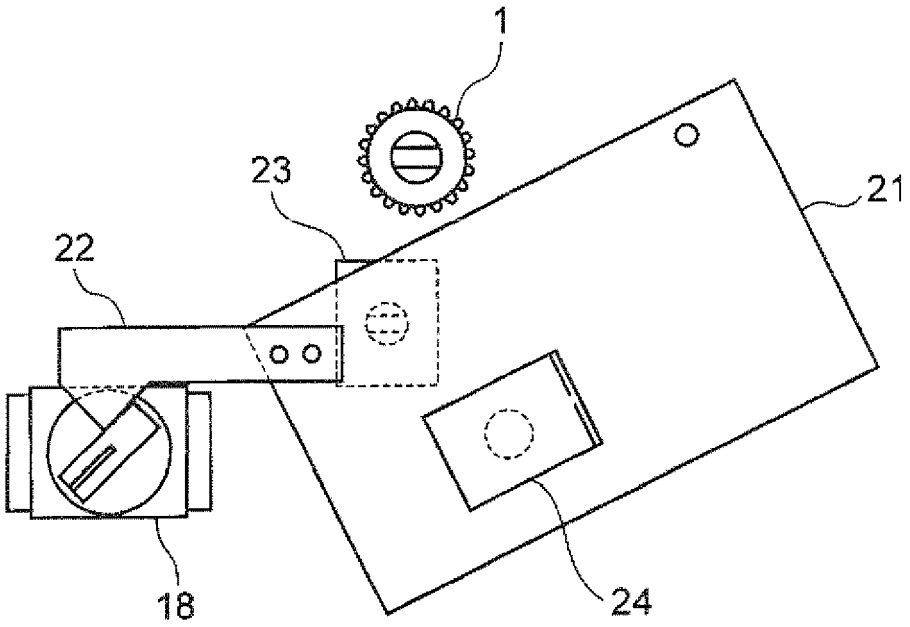

FIG.7

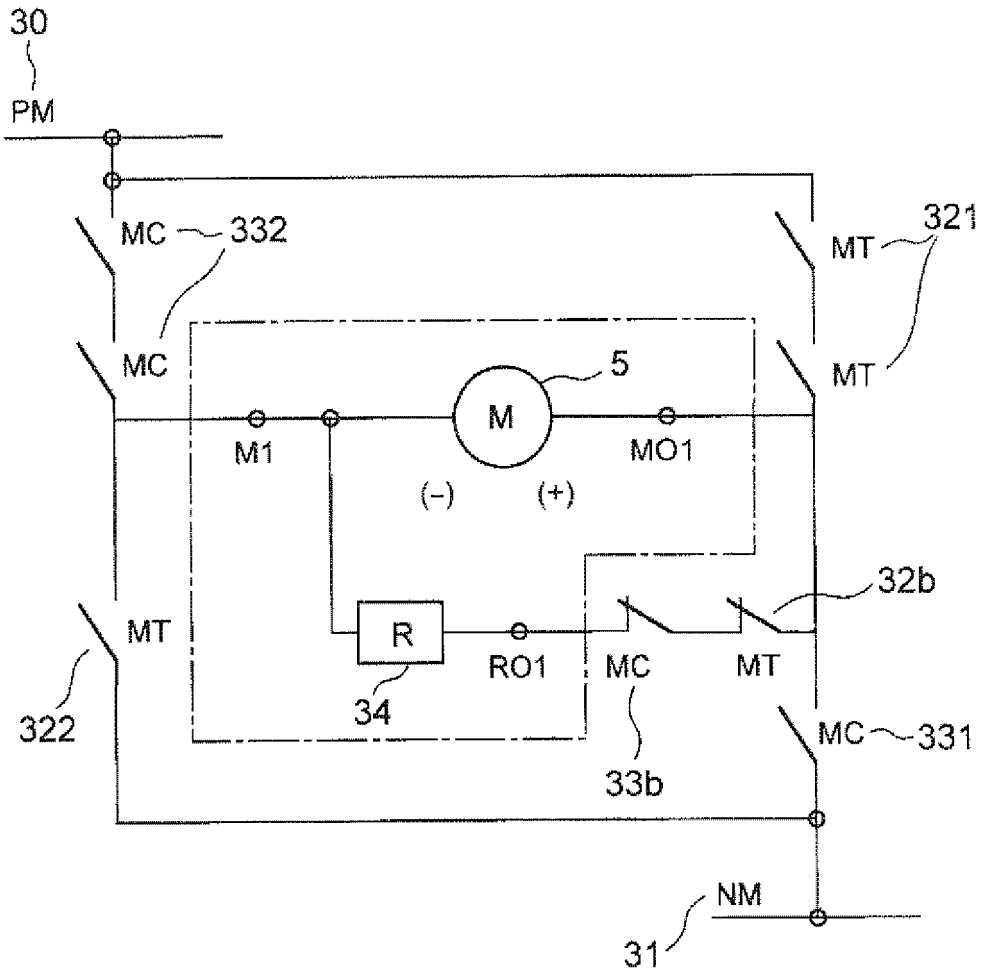
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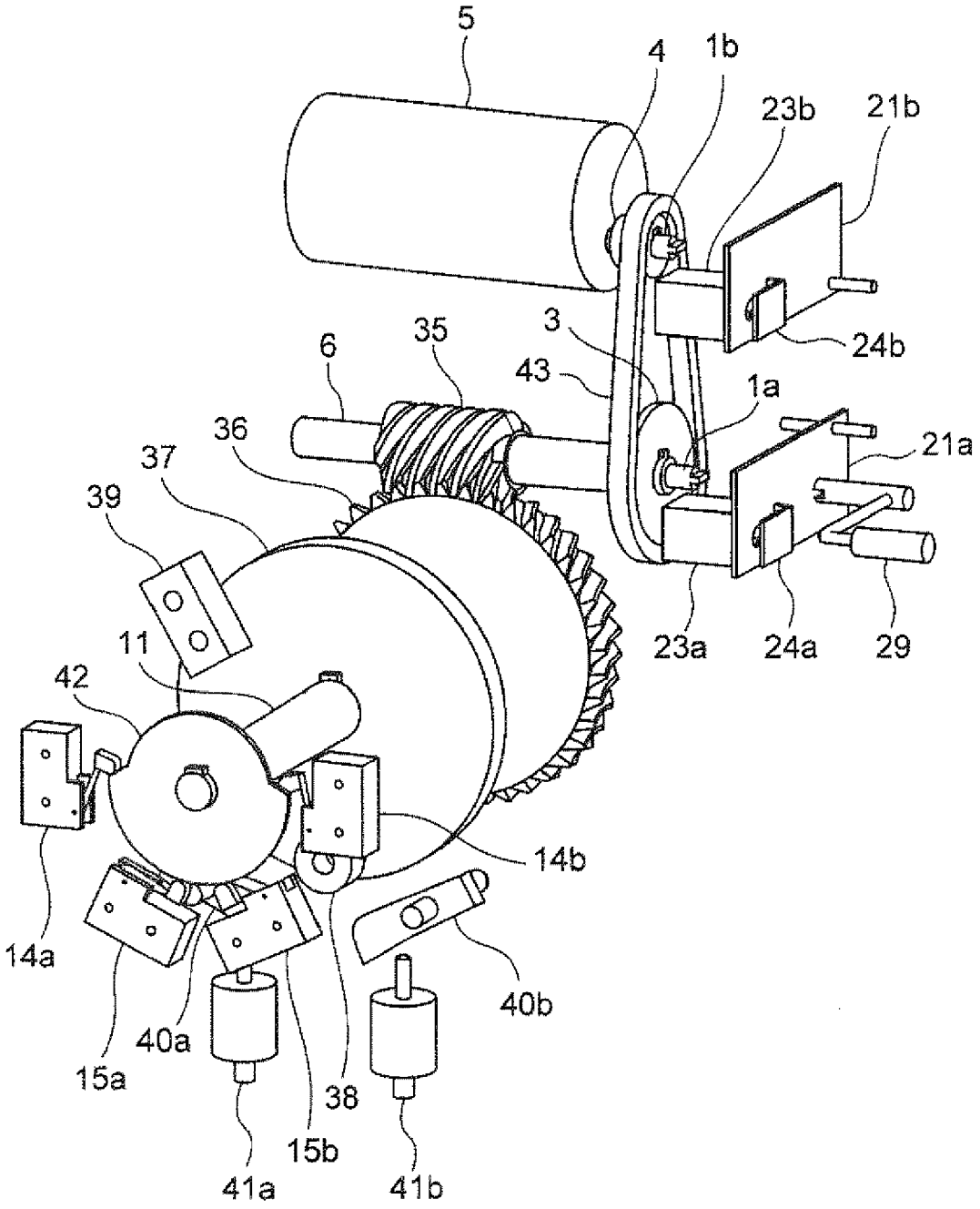
FIG.8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EUROPEAN SEARCH REPORT

Application Number
EP 11 15 0702

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A	JP 2002 152922 A (TOSHIBA CORP) 24 May 2002 (2002-05-24) * abstract; figure 1 *	1	INV. H01H3/40 H01H3/42
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H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	26 April 2011	Findeli, Luc

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26-04-2011

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