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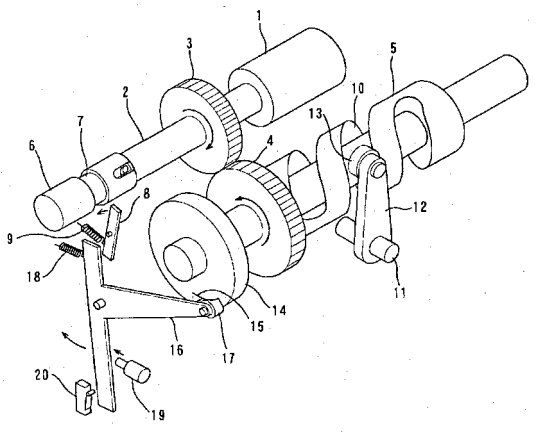
(54) OPERATING UNIT FOR SWITCHGEAR

(57) Disclosed is an operating mechanism capable of achieving enhanced accuracy in a stop position of a switch in motor operation and in a stop position of the switch (in pulling out position of a manual handle) in manual operation. The operating mechanism comprises a grooved cam shaft 5 having a cylindrical surface formed with a groove 10 engaged with a roller 13. The grooved cam shaft 5 is designed to be rotated so as to drive the roller 13 to thereby rotate an output shaft 11, and the groove 10 is configured such that an axial displacement rate thereof relative to a rotation of the grooved cam shaft 5 is minimized around a position corresponding to each stop position of the switch to prevent the output shaft 11 from being rotated even if the grooved cam shaft 5 is rotated.

FIG. 1



EP 1 662 532 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to an operating mechanism for a switch, and more particularly to an operating mechanism for a switch designed to have both functions of a disconnecting switch and an earthing switch and to be switched between three positions "CLOSED", "OPEN" and "EARTHED" by a single operating unit.

BACKGROUND ART

[0002] There has been known a three-position switch, such as a disconnecting switch with an earthing switch; which is designed to have both functions of a disconnecting switch and an earthing switch and to be switched between three positions "CLOSED", "OPEN" and " EARTHED" by a single operating unit. For example, Japanese Patent Laid-Open Publication No. 2003-22735 (Patent Publication 1) discloses an operating mechanism for such a three-position switch.

[0003] The operating mechanism disclosed in the Patent Publication 1 is designed to rotate an output shaft using either a motor or a manual handle so as to operate the three-position switch between "CLOSED", "OPEN and "EARTHED". More specifically, the operating mechanism comprises: a cam plate fixed to the output shaft and formed with three depressions at positions corresponding to the switch positions "CLOSED", " OPEN "and" EARTHED ";pins formed on a surface of the cam plate and adapted to be brought into contact with four limit switches for stopping the motor; a cam-follower lever which is provided with a locking roller and a on-cam rolling roller biasedly pressed onto and rolled along a circumferential edge of the cam plate, and adapted to be vertically moved according to a rotation of the cam plate; a retaining latch formed with a concave portion and adapted to allow the locking roller to be engaged with the concave portion when the on-cam rolling roller is located at each of the depressions of the cam plate corresponding to the switch positions "CLOSED", "OPEN" and "EARTHED", so as to lock a rotation of the output shaft; limit switches for detecting the engagement between the on-cam rolling roller and each of the depressions of the cam plate; a lock release member adapted to be moved according to a horizontal movement of a lock lever so as to disengage the locking roller from the concave portion of the retaining latch to release the lock; and a lock release rod adapted to be driven by a magnet.

[0004] The operating mechanism disclosed in the Patent Publication 1 has the following problems:

(1) Wide variation in stop position of a switch during motor operation: While, each of the limit switches is activated just before each target stop position to electrically brake a motor, the stop position is largely varied due to motor's braking characteristic depending on load torque and operating voltage;

(2) Wide variation in stop position of the switch during manual operation: While the operating mechanism is designed to inhibit a manual handle from being pulled out except that the switch is in a given stop position, allowable range of handle pulling-out is relatively wide; and

(3) Complexity in control system: The operating mechanism includes the four limit switches for detecting respective target stop positions, and thereby requires a number of auxiliary relays.

DISCLOSURE OF THE INVENTION

[0005] The present invention is directed to provide a switch operating mechanism capable of achieving enhanced accuracy in a stop position of a switch during an electric motor-based operation and in a stop position of the switch (in detachable position of a manual handle) during a manual handle-based operation, while reducing the number of auxiliary relays to simplify a control system.

[0006] The feature of the present invention is generally summarized as follows.

(1) An operating mechanism of the present invention comprises a grooved cam shaft designed to be rotated so as to drive a roller to thereby rotate an output shaft.

(2) The grooved cam shaft may have a groove configured such that an axial displacement of the groove relative to a rotation of the grooved cam shaft is minimized around a position corresponding to a stop position of the switch to prevent the output shaft from being rotated even if the motor is rotated.

(3) The grooved cam shaft may have a groove configured such that an axial displacement rate of the groove relative to a rotation of the grooved cam shaft is in approximately inverse proportional to a load torque of the switch so as to achieve constant load torque for the motor.

(4) The grooved cam shaft may include a cam plate formed with a concave portion designed to allow a bump roller to fall therein and bump thereagainst so as to stop a rotation of the grooved cam shaft.

(5) A state when the bump roller is in the falling position may be detected using a limit switch to stop the motor.

(6) A manual handle may be inhibited from being pulled out except that the bump roller is in the falling position.

BRIEF DESCRIPTION OF DRAWINGS

[0007]

FIG. 1 is a perspective view showing an operating mechanism according to one embodiment of the

present invention.

FIG 2 illustrates one example of the configuration of a groove of a grooved cam shaft in the operating mechanism.

FIG. 3 is a graph showing the groove configuration illustrated in FIG. 2.

FIG. 4 is a graph showing a torque conversion rate in the groove configuration illustrated in FIG. 2.

BEST MODE FOR CARRYING OUT THE INVENTION

[0008] FIG. 1 is a perspective view showing an operating mechanism according to one embodiment of the present invention. In FIG. 1, the operating mechanism is designed to transmit a torque of a motor 1 to a grooved cam shaft 5 through a spur gear 3 of a motor shaft 2 and a spur gear 4 engaged with the spur gear 3.

[0009] In place of the motor 1, a manual handle 6 may be connected to the motor shaft 2 to rotate the spur gear 4 so as to rotate the grooved cam shaft 5. The manual handle 6 is formed with a groove 7, and an inhibition plate 8 for inhibiting the manual handle 6 from being inserted and pulled out from the motor shaft 2 is disposed adjacent to the groove 7 in an engageable manner relative to the groove 7. The inhibition plate 8 is biased in a direction away from the groove 7 by a spring 9. When the inhibition plate 8 is engaged with the groove 7, the manual handle 6 is inhibited from being pulled out of the motor shaft 2.

[0010] The grooved cam shaft 5 has an outer peripheral surface formed with a groove 10 axially extending continuously like a spiral. The groove 10 receives therein a roller 13 which is attached to one end of a lever 12 having the other end fixed to an output shaft 11 associated with a switch. When the grooved cam shaft 5 is rotated, the roller 13 is swung rightward or leftward (in FIG. 1) about the lever 12 while being guided along the groove 10.

[0011] A cam plate 14 is fixed to one end of the grooved cam shaft 5. The cam plate 14 is formed with a concave portion 15 adapted to be engageable with a bump roller 17 attached to a first end of a T-shaped cam-follower lever 16. The cam-follower lever 16 is biased by a reset spring 18 attached to a second end thereof in such a manner as to allow the bump roller 17 to be engaged with the concave portion 15. When a third end of the cam-follower lever 16 is pushed by a release coil 19, the cam-follower lever 16 is swung to disengage the bump roller 17 from the concave portion 15 so as to allow the grooved cam shaft 5 to be rotated. Simultaneously, a limit switch 20 is activated by the pushed cam-follower lever 16 to detect this state and turn on a drive circuit of the motor 1.

[0012] In manual operation, when the cam-follower lever 16 is pushed by the release coil 19, the inhibition plate 8 is moved by the second end of the cam-follower lever 16 and engaged with the groove 7 of the manual handle 6 to inhibit the manual handle 6 from being pulled out of the motor shaft 2.

[0013] An operation of the operating mechanism according to this embodiment will be described below.

(1) Motor Operation

[0014] In FIG. 1, the operating mechanism is in an intermediate position ("OPEN" position in the case of the switch has three positions "CLOSED", "OPEN" and "EARTHED"). In this position, the bump roller 17 falls in the concave portion 15 of the cam plate to lock the rotation of the grooved cam shaft 5.

[0015] When a control unit (not shown) receives a command for closing operation, the release coil 19 is energized according to the control unit to push the cam-follower roller 16. Thus, the cam-follower roller 16 is swung clockwise against the reset spring 18, and the bump roller 17 is moved to disengage from the concave portion 15 of the cam plate 14 so as to allow the grooved cam plate 5 to be rotated. Simultaneously, the limit switch 20 detects this state and turns on the drive circuit of the motor 1.

[0016] Thus, the motor 1 is rotated, and a torque of the motor 1 is transmitted to the grooved cam shaft 5 through the spur gears 3, 4 to rotate the grooved cam shaft 5 counterclockwise. The roller 13 engaged with the groove 10 of the grooved cam shaft 5 is driven or swung leftward (in FIG 1), and the output shaft 11 is rotated through the lever 12 in a counterclockwise direction (direction to the "CLOSED" position). In the state after the grooved cam shaft 5 is rotated at some degrees, the bump roller 17 is placed and rolled on a circular circumferential surface of the cam plate 14 to maintain the rotatable state of the grooved cam shaft 5. The limit switch 20 detects this state to de-energize the release coil 19.

[0017] Then, when the grooved cam shaft 5 is rotated at about 360-degree, the bump roller 17 falls in the concave portion 15 of the cam plate 14, and the cam-follower lever 16 is swung counterclockwise. The limit switch 20 detects this state to turn off the drive circuit of the motor 1. While the motor 1 inertially rotates for a while, it will be completely stopped when the bump roller 17 bumps against a wall surface of the concave portion 15 of the cam plate.

[0018] FIG. 2 shows one example of the configuration of the groove 10 of the grooved cam shaft 5, and FIG 3 is a graph showing the groove configuration. FIG. 4 is a graph showing a torque conversion rate in the groove configuration. The groove 10 is configured to have no axial displacement around each of three positions corresponding to the three stop positions of the switch. Thus, even if the bump roller 17 is stopped at any position within the concave portion 15 of the cam plate 14, a stop position of the output shaft 11 is not varied.

[0019] In FIG 2, an axial displacement rate relative to an angle of the groove 10 is arranged to become smaller on the side of the "CLOSED" and "EARTHED" positions and become larger on the side of the "OPEN" position. Thus, as shown in FIG. 4, a torque conversion rate (output shaft torque/motor shaft torque) has a similar characteristic to that of a load torque in a body of the switch.

This makes it possible to maintain a load torque of the electric motor 1 at an approximately constant value.

(2) Manual Operation

[0020] In FIG 1, the bump roller 17 falls in the concave portion 15 of the cam plate 14 to lock the rotation of the grooved cam shaft 5, and the inhibition plate 8 is returned to its initial position to allow the manual handle 6 to be inserted and pulled out from the motor shaft 2.

[0021] In this state, the manual handle 6 is inserted to the motor shaft 2. Then, a manual switch (not shown) is pushed to energize the release coil 19. Thus, the cam-follower lever 16 is swung clockwise to disengage the bump roller 17 from the concave portion 15 of the cam plate so as to allow the grooved cam shaft 5 to be rotated.

[0022] When the manual handle 6 is rotated clockwise, the grooved cam shaft 5 is rotated counterclockwise. Thus, the roller 13 engaged with the groove 10 of the grooved cam shaft 5 is driven or swung leftward (in FIG. 1), and the output shaft 11 is rotated through the lever 12 in a counterclockwise direction (direction to the "CLOSED" position). In the state after the grooved cam shaft 5 is rotated at some degrees, the bump roller 17 is placed and rolled on the circular circumferential surface of the cam plate 14 to maintain the rotatable state of the grooved cam shaft 5. The limit switch 20 detects this state to de-energize the release coil 19. During this process (midway position), the inhibition plate 8 is engaged with the groove 7 of the manual handle 6 to inhibit the manual handle 6 from being pulled out of the motor shaft 2.

[0023] Then, when the grooved cam shaft 5 is rotated at about 360-degree, the bump roller 17 falls in the concave portion 15 of the cam plate 14, and the cam-follower lever 16 is swung counterclockwise. When the grooved cam shaft 5 is further rotated, the bump roller 17 bumps against the wall surface of the concave portion 15 of the cam plate 14 to completely stop the grooved cam shaft 5. Thus, the inhibition plate 8 is returned to the initial position by the spring 9 to allow the manual handle 6 to be inserted and pulled out from the motor shaft 2.

[0024] The switch operating mechanism according to the above embodiment has the following effects.

(1) The groove of the grooved cam shaft is configured such that an axial displacement rate of the groove relative to a rotation of the grooved cam shaft is minimized around a position corresponding to each of the stop positions of the switch to prevent the output shaft from being Stated even if the motor is rotated. This makes it possible to achieve enhanced accuracy in stop position of the switch in motor operation.
(2) The manual handle can be pulled out only if the bump roller is engaged with the concave portion of the cam plate (in this state, the output shaft cannot be rotated by the manual handle). This makes it possible to achieve enhanced accuracy in stop position of the switch (in pulling out position of the manual handle) in manual operation.
(3) The grooved cam shaft is stopped by the bump between the bump roller and the concave portion of the cam plate. This makes it possible to eliminate the need for dynamic braking of the motor.
(4) An axial displacement rate relative to an angle of the groove is arranged to become smaller on the side of the "CLOSED" and "EARTHED" positions and become larger on the side of the "OPEN" position. Thus, a torque conversion rate (output shaft torque/motor shaft torque) has a similar characteristic to that of a load torque of the switch. This makes it possible to maintain a load torque of the motor at an approximately constant value and reduce the load torque of the motor.
(5) Only one limit switch is required for the stop control. This makes it possible to achieve a simplified control system.

Claims

1. An operating mechanism comprising:

an output shaft for transmitting a driving force to a movable part of a switch;
a lever having one end integral with an end of said output shaft;
a roller rotatablyattached to the other end of said lever; and
a grooved cam shaft having a cylindrical surface formed with a groove engaged with said roller, said grooved cam shaft being designed to be rotated so as to drive said roller to thereby rotate said output shaft.

2. The switch operating mechanism as defined to claim 1, wherein said grooved cam shaft has a groove configured such that an axial displacement rate of the groove relative to a rotation of the grooved cam shaft is reduced around a position corresponding to a stop position of the switch.

3. The switch operating mechanism as defined to claim 1, wherein said grooved cam shaft has a groove configured such that an axial displacement rate of the groove relative to a rotation of the grooved cam shaft is in approximately inverse proportional to a load torque of the switch.

4. The switch operating mechanism as defined to claim 1, which includes a disc-shaped cam plate integrated with said grooved cam shaft and partly formed with a concave portion, and a bump roller is biasedly disposed and rolled at a periphery of said cam plate and adapted to fall in and bump against said concave portion of said cam plate every 360-degree rotation of said grooved cam shaft so as to stop the rotation

of said grooved cam shaft.

5. The switch operating mechanism as defined to claim 4, which includes a motor for driving said grooved cam shaft, and a limit switch for detecting that said bump roller is in the falling position, so as to stop said motor.

6. The switch operating mechanism as defined to claim 4, which includes a manual handle for driving said grooved cam shaft, and means for inhibiting said handle from being inserted and pulled out from said operating mechanism except that said bump roller is in the falling position.

FIG. 1

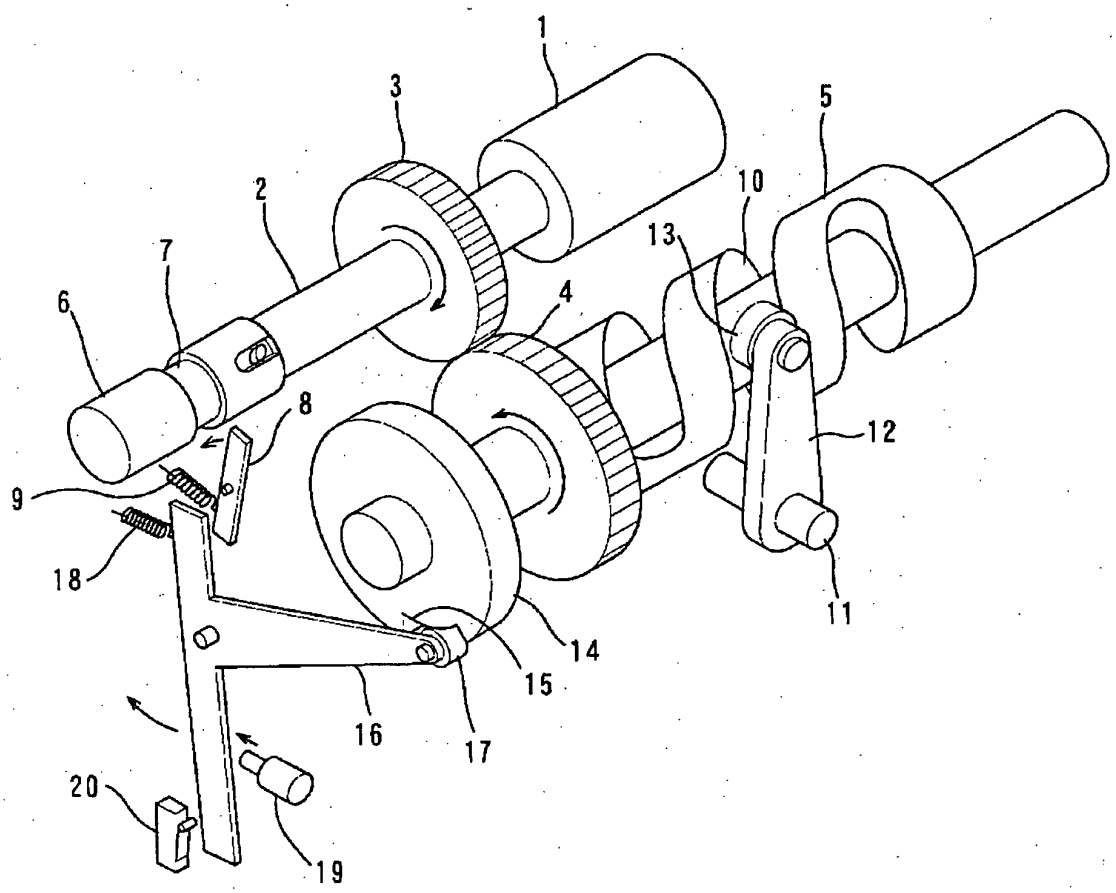
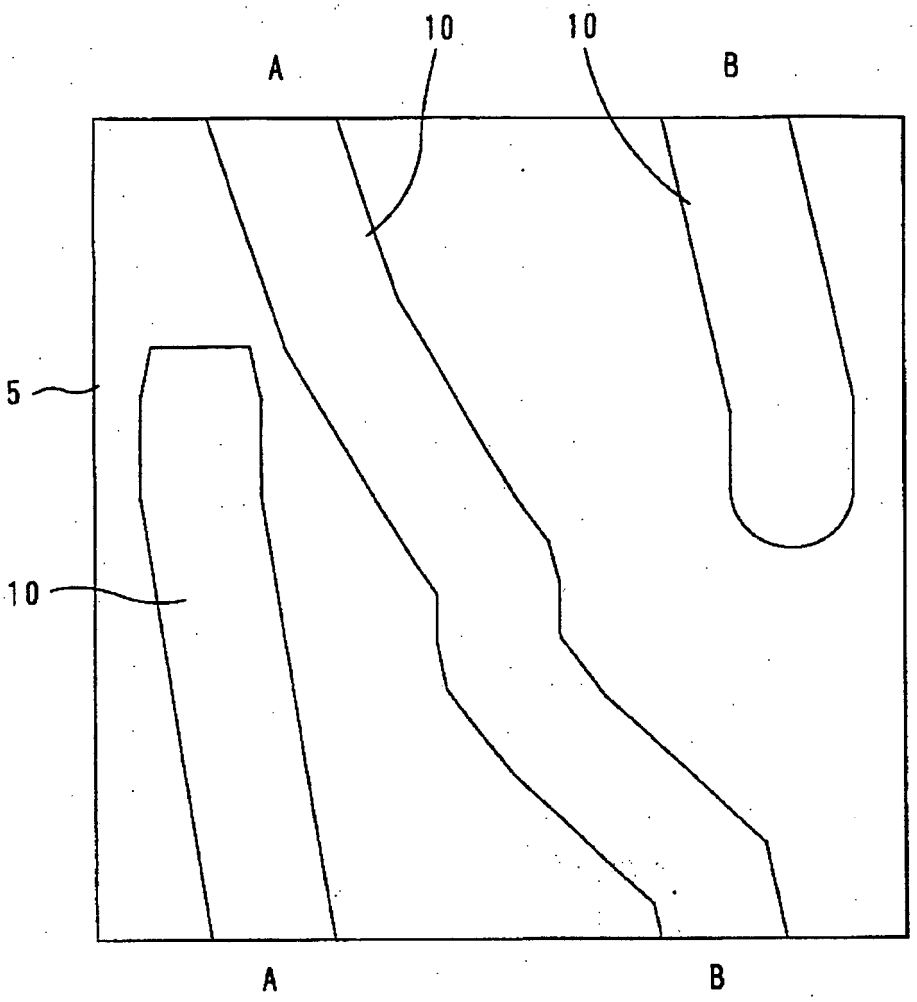
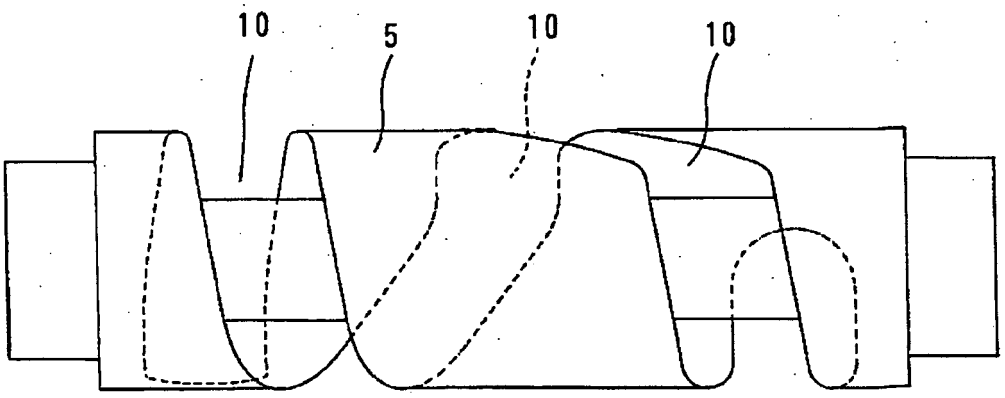


FIG. 2



(a)



(b)

FIG. 3

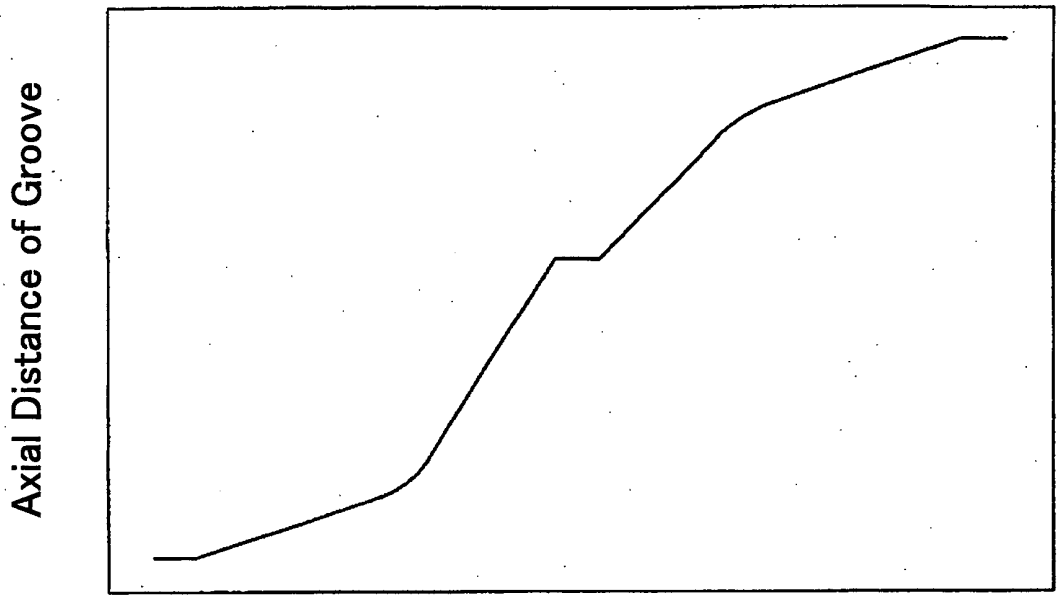
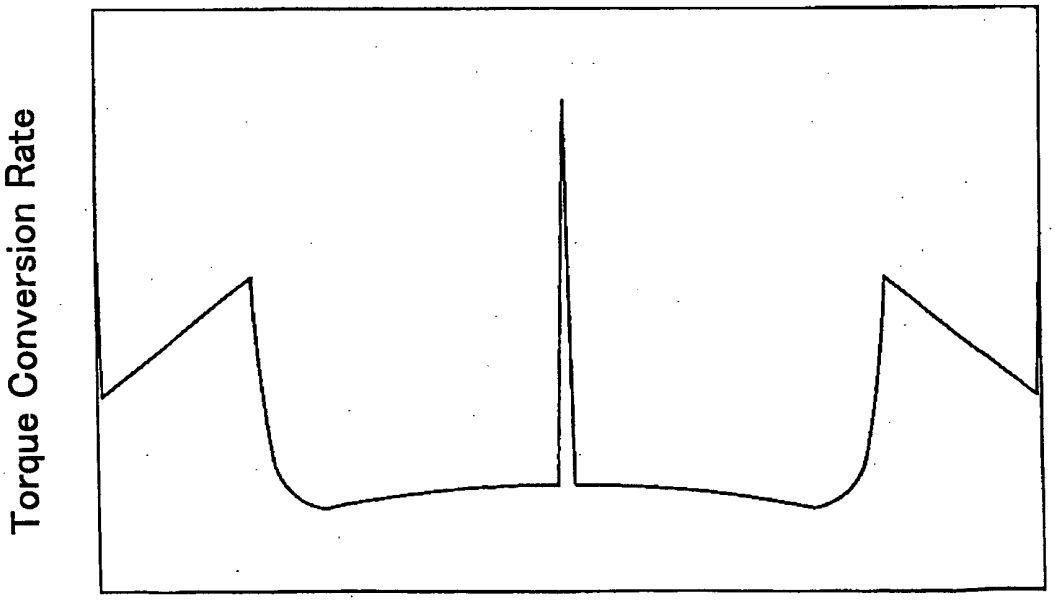

Axial Distance of Groove
Rotation Angle of Grooved Cam Shaft

FIG. 4


Torque Conversion Rate
Rotation Angle of Output Shaft

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/17084

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] H01H33/42

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] H01H33/42, H01H33/40, H01H3/42, H01H3/26

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1940-1996	Toroku Jitsuyo Shinan Koho	1994-2004
Kokai Jitsuyo Shinan Koho	1971-2004	Jitsuyo Shinan Toroku Koho	1996-2004

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 40564/1984(Laid-open No. 153443/1985) (Nisshin Denki Kabushiki Kaisha), 12 October, 1985 (12.10.85), Full text; Figs. 1 to 13 (Family: none)	1-6
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 160022/1988(Laid-open No. 80926/1990) (Nisshin Denki Kabushiki Kaisha), 21 June, 1990 (21.06.90), Full text; Figs. 1 to 3 (Family: none)	1-6

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search 02 March, 2004 (02.03.04)	Date of mailing of the international search report 23 March, 2004 (23.03.04)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/17084

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 58850/1985(Laid-open No. 177334/1986) (Nisshin Denki Kabushiki Kaisha), 05 November, 1986 (05.11.86), Full text; Figs. 1 to 10 (Family: none)	1-6
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 77206/1972(Laid-open No. 34973/1974) (Mitsubishi Electric Corp.), 27 March, 1974 (27.03.74), Full text; Figs. 1 to 6 (Family: none)	1-6

Form PCT/ISA/210 (continuation of second sheet) (July 1998)