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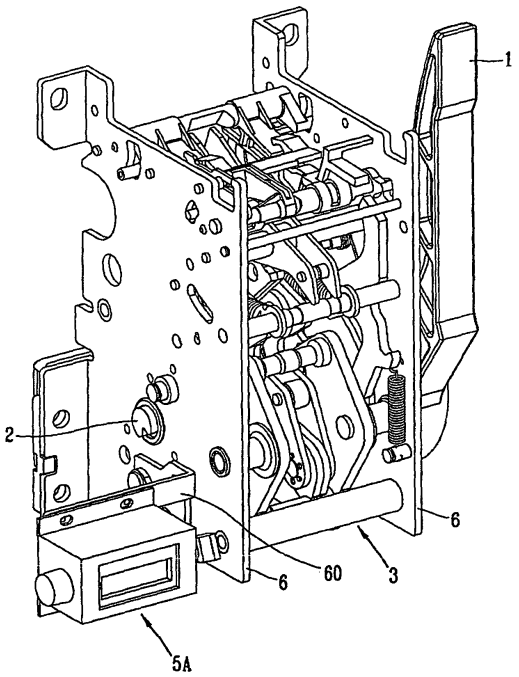
(54) Operation counter driving apparatus for air circuit breaker

(57) A mechanical operation counting apparatus for counting the number of times a circuit of an air circuit breaker is closed, while performing a closing or opening operation of a switching unit, is provided with a driving apparatus to prevent an impact caused by a momentarily large force applied by a closing spring or opening spring, including: a cam (4) having an outer circumferential surface formed with a cam profile with a varying radius of curvature, a working lever having one end portion contacting the cam surface and pivoting according to a contact position thereof on the cam surface, a counter operating lever (52) having one end contacting the working lever and pivoted by engagement with the working lever, and the counter (51) being driven by the pivoting of the counter operating lever and counting and displaying the number of times the circuit of the air circuit breaker is closed.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to an air circuit breaker, and more particularly, to an operation counter driving apparatus for an air circuit breaker by which is driven a mechanical counter which counts the number of times the circuit of the air circuit breaker is opened/closed.

2. Description of the Background Art

[0002] In general, an air circuit breaker is an electric device which can opens or close a circuit between a power source and a load or when an abnormal current flows on the circuit due to an electric shortage or the like, can senses such flow and automatically breaks the circuit thus to protect the electrical system.

[0003] Accordingly, an air circuit breaker includes a fixed contactor for being connected at one side of a power source of a circuit or a load; a movable contactor for being connected to another side of the circuit which is not connected to the fixed contactor and which is movable to a position for contacting the fixed contactor and to a position for being separated from the fixed contactor; and a switching unit for driving the movable contactor to the opening or closing position. If the switching unit has a mechanism in which a driving force necessary for closing or opening movement of the movable contactor is obtained by utilizing the elastic potential energy charged in a spring, the switching unit is provided with a closing spring and an opening spring. In such am arrangement, the opening spring may be charged with elastic potential energy by utilizing the kinetic energy discharged when the closing spring drives a closing operation, and uses this charged energy when the switching unit drives an opening operation. Accordingly, it is required to charge the closing spring such that a driving energy of the switching unit can be obtained. In order to charge such closing spring, a charging mechanism using manual power applied by a user's manipulation of a charging handle or using a motor is implemented. In general, a recent trend is driving development of an air circuit breaker having both a manual mechanism and an automatic mechanism for charging such closing spring.

[0004] Meanwhile, in order to monitor an operation lifetime of an air circuit breaker and a time to replacing the components thereof, a operation counter apparatus for counting the number of times the circuit of the air circuit breaker is opened/closed is additionally installed in the air circuit breaker.

[0005] However, a related art operation counter arrangement for an air circuit breaker has a structure in which excessive force generated when the closing spring drives a closing operation of the contacts is directly applied to a driving mechanism of the operation counter apparatus. Accordingly, due to the excessive force applied thereto, the components of the driving mechanism of the operation counter apparatus may be damaged or broken, thereby causing a defective state of the operation counter apparatus not being capable of performing its counting function.

SUMMARY OF THE INVENTION

[0006] Therefore, it is an object of the present invention to provide a driving apparatus for an operation counter for an air circuit breaker which can enable the operation counter to be driven stably and thereby reliably perform an operation of counting and displaying the number of times the contacts are closed, by buffering an force generated when the closing spring is discharged when performing a contact closing operation and transferring the force to a driving mechanism of the operation counter apparatus thus to prevent the damage of components of the driving mechanism.

[0007] To achieve this and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described herein, in an air circuit breaker, which includes a rotation shaft, and a closing spring for charging therein elastic potential energy by a rotation force of the rotation shaft, and which closes a circuit by using the elastic potential energy charged in the closing spring, there is provided an operation counter driving apparatus, including:

a cam coaxially connecting to the rotation shaft, and having an outer circumferential surface thereof formed with a cam profile with a varying radius of curvature, for buffering and transferring the rotation force of the rotation shaft to a mechanical counter so as to count the number of times the circuit of the air circuit breaker is closed.

[0008] In an air circuit breaker, which includes a rotation shaft, and a closing spring for charging therein elastic potential energy by a rotation force of the rotation shaft and which closes contacts of the circuit breaker by using the elastic potential energy charged in the closing spring, there is provided an operation counter driving apparatus, including:

a cam coaxially connected to the rotation shaft so as to be rotatable with the rotation shaft, and having an outer circumferential surface thereof formed with a cam profile with a varying radius of curvature, for buffering and transferring the rotation force of the rotation shaft;

a working lever having a portion contacting the outer circumferential surface of the cam, and being pivotable according to a contact position thereof on the outer circumferential surface of the cam;

a mechanical counter having a drive shaft for receiv-

ing operating power; and

a counter operating lever connected to the drive shaft of the counter, having one end contacting the working lever, and pivotally by cooperating arrangement with the working lever for thereby transferring a driving force of the working lever to the drive shaft of the counter to count and display the number of times the circuit of the air circuit breaker is closed.

[0009] In an air circuit breaker which includes a rotation shaft and a switching unit having a closing spring for charging therein elastic potential energy by a rotation force of the rotation shaft, and which closes the contacts of the circuit breaker by using the elastic potential energy charged in the closing spring, there is provided an operation counter driving apparatus, including:

a cam coaxially connected to the rotation shaft so as to be rotatable with the rotation shaft, and having an outer circumferential surface formed with a cam profile with a varying radius of curvature, for buffering and transferring the rotation force of the rotation shaft;

a working lever having a central portion pivotally supported by a pivot pin at a side plate, a first extending portion extending from the central portion in one direction and contacting the outer circumferential surface of the cam, a second extending portion extending from the central portion in another direction, and a pair of leg portions disposed at an end of the second extending portion and having an elongate groove therebetween, and pivoting according to a contact position thereof on the outer circumferential surface of the cam;

a mechanical counter for counting the number of times the circuit of the air circuit breaker is closed; and

a counter operating lever connected between the counter and the working lever, having a portion contacting the pair of leg portions in the elongate groove of the working lever, and pivoting by engagement with the working lever, for thereby transferring a driving force to the counter to count and display the number of times the circuit of the air circuit breaker is closed.

[0010] The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

[0012] In the drawings:

Figure 1 is a perspective view illustrating a switching unit of an air circuit breaker, and an operation counter and driving apparatus thereof for the air circuit breaker mounted next to the switching unit, according to a first embodiment of the present invention;

Figure 2 is an exploded perspective view illustrating the components, except a cam, of the operation counter driving apparatus for an air circuit breaker according to the first embodiment of the present invention;

Figure 3 is a perspective view illustrating an assembled state of the operation counter driving apparatus of an air circuit breaker according to the first embodiment of the present invention;

Figures 4 through 6 are state diagrams respectively illustrating operation states of the operation counter driving apparatus for an air circuit breaker according to the first embodiment of the present invention;

Figure 7 is a perspective view illustrating a switching unit of an air circuit breaker, and an operation counter driving apparatus thereof for the air circuit breaker mounted next to the switching unit, according to a second embodiment of the present invention;

Figure 8 is a perspective view illustrating only the operation counter and the driving apparatus therefore to show the structure of the operation counter driving apparatus for an air circuit breaker according to the second embodiment of the present invention; and

Figures 9 through 11 are state diagrams respectively illustrating operation states of the operation counter driving apparatus for an air circuit breaker according to the second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0013] Description will now be given in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0014] Referring to Fig. 1, an air circuit breaker includes a switching unit 3, which provides a driving force to perform an opening or closing operation of the contacts and is supported between a pair of vertical side plates 6 at both sides thereof. A charging handle 1 for manually charging a closing spring (not shown) is rotatably mounted at one side of the switching unit 3. An operation counter driving apparatus 5A of the air circuit breaker according to a first embodiment of the present invention is supported by a support bracket 60 at the other side of the switching unit 3. Reference numeral 2 denotes a rotation shaft, which is directly or indirectly connected to a rotation shaft of the handle 1 or a rotation shaft of a motor (not shown) so as to charge an elastic potential energy in the

closing spring, and provides the force for charging elastic potential energy in the closing spring.

[0015] As shown in Fig. 3, the operation counter driving apparatus 5A includes a cam 4 coaxially connected to a rotation shaft 2, and having an outer circumference formed with a cam profile surface with a varying radius of curvature, for buffering and transferring the rotation force (torque) of the rotation shaft 2 to an operating lever 52 of a mechanical counter 51 so as to count the number of times the contacts of the air circuit breaker are closed. The outer circumferential surface of the cam 4 includes a first surface portion 42 having a large radius of curvature, and a second surface portion 41 having a concaved surface with a progressively decreasing radius of curvature and then a sharply decreasing radius of curvature, when compared to that of the first surface portion 42. The profile of the cam 4 is not limited to those described in reference to the embodiments shown in Figs. 5 through 8, but may have variously modified profiles under a condition that an outer circumferential surface has a cam profile with a varying radius of curvature (i.e., a surface portion with an increasing radius of curvature and a surface portion with a decreasing radius of curvature).

[0016] As shown in Figs. 2 and 3, the operation counter driving apparatus 5A according to the first embodiment of the present invention includes, in addition to the cam 4, a working lever 53 having a cam follower contacting the outer circumferential surface of the cam 4 and pivoting according to a contact position of the cam follower on the outer circumferential surface of the cam 4.

[0017] The operation counter driving apparatus 5A further includes the mechanical counter 51 for displaying the number of times the contacts of the air circuit breaker are closed. The mechanical counter 51 may be of a conventional and commonly available type, such as a ratchet drive tally counter, counting each time an operating lever thereof is displaced by a certain angular stroke amount , and includes a drive shaft (referring reference numeral 51 a in Fig. 4) for receiving driving force for performing a counting operation.

[0018] The operation counter driving apparatus 5A further includes a counter operating lever 52 which is connected at one end thereof to the drive shaft of the mechanical counter 51, and having its other, free end 56 contacted by free end of the working lever 53, and being rotated by engagement with the working lever 53, thereby transferring a driving force to the drive shaft 51a of the mechanical counter 51 to thereby operate a counting mechanism therein so as to count and display the number of times the contacts of the air circuit breaker are closed.

[0019] Figure 2 shows a disassembled perspective view illustrating the components, except a cam, of the operation counter and driving apparatus thereof for an air circuit breaker according to the first embodiment of the present invention. Referring to Fig. 2, the components of the operation counter driving apparatus according to one embodiment of the present invention will be described in detail from top to bottom.

[0020] First, a pivot pin 54 includes a head portion, a cylindrical body portion 54 having a diameter smaller than the head portion and a smooth circumferential surface and providing a pivot point of the working lever 53, and a leg portion 54b having an outer thread for being threaded into a mounting hole 62 in the support bracket 60.

[0021] The leg portion 54b protrudes through the mounting hole 62 in the support bracket 60 such that the end portion of the pivot pin 54 protruding toward an outside of the support bracket 60 can be fixed at the outer side of the support bracket 60 by a fixing pin or clip (not shown) so as to prevent a separation of the pivot pin 54 in an axial direction.

[0022] Alternatively, the pivot pin 54 may be replaced with a rivet without any threaded portion, and an end portion of the rivet protruding toward the outside of the support bracket 60 through the mounting hole 62 may be flattened or compressed, for thereby preventing its movement in the axial direction.

[0023] The working lever 53 includes at its lower end of the end portion 57 for contacting the free end 56 of the counter operating lever 52 of the mechanical counter, a through hole 58 at an upper end of the working lever 53 for accommodating the body portion 54a of the pivot pin 54, and a cam follower 55 extending perpendicularly from a central portion of the working lever 53 for contacting the outer circumferential surface of the cam. Preferably, the cam follower 55 contacting the outer circumferential surface of the cam is formed with a cylindrical or rounded shape so as to reduce contact friction therebetween.

[0024] The support bracket 60 is an approximately "L" shaped plate formed by two perpendicular plates consisting of a long plate portion and a short plate portion. The mechanical counter 51 is fixed at a base thereof to the surface of the long plate portion by a fixing means, such as screws and nuts (not shown). A rectangular-shaped opening is provided in the long plate portion such that the one end portion 57 of the working lever 53 can pass therethrough so as to contact the counter drive lever 52. An elongate slot 61 is disposed in an approximately central part of the short plate portion of the support bracket 60 such that the cam follower 55 of the working lever 53 moving according to its contact position on the outer circumferential surface of the cam can pass therethrough toward a front surface from a rear surface thereof and thus can ride therein. A mounting hole 62 for the pivot pin 54 is disposed in an upper corner of the short plate portion in a diagonal direction from the elongate slot 61. An internal thread for engaging the external thread of the leg portion 54b of the pivot pin 54 is formed in the mounting hole 62.

[0025] As is well known in the art, numeric indicator dials (not shown) for displaying a count tally and the drive shaft are provided inside the mechanical counter 51. Also, the mechanical counter 51 includes an outer case for accommodating and protecting the numeric indicator dials. As shown in Figs. 3 and 5, upper and lower portions of the outer case is provided with extending mounting

flanges or lugs having mounting holes therein through which can be inserted fixing means for mounting the counter 51 to the support bracket 60.

[0026] The counter operating lever 52 is connected to the drive shaft 51 a of the counter 51for transferring a driving force thereto. Preferably, the end portion 56 of the counter operating lever 52, which contacts the one end portion 57 of the working lever 53 is formed to have a rounded surface to reduce friction therebetween.

[0027] A torsion spring (not shown) is installed between the counter operating lever 52 and the drive shaft 51 a of the mechanical counter 51 or on the drive shaft of the counter 51 so as to urge the counter operating lever 52 and the drive shaft 51 a of the mechanical counter 51 to rotate in one direction (in this example, in a counterclockwise direction towards contacting engagement between the end 56 of the counter operating lever 52 and the end 57 of the working lever 53). Accordingly, if the position where the cam follower 55 of the working lever 53 in Fig. 3 contacts the cam 4 is at any part of the first surface portion 42 having a large radius of curvature, the end portion 56 of the counter operating lever 52 is depressed downwardly. If the cam follower 55 is engaged on the second surface portion 41 of the cam 4 having a smaller radius of curbature, the end portion 56 of the counter operating lever 52 is urged upward by the elasticity of the spring (not shown).

[0028] The cam 4, most of the rotation shaft 2 and the cam follower 55 of the working lever 53 as shown in Fig. 3 are located inside the switching unit 3 between the side plates 6 in Fig. 1, thus are not visible in Fig. 1.

[0029] The operation of the operation counter driving apparatus 5A for an air circuit breaker with such configuration according to the first embodiment of the present invention will be explained in detail with reference to Figs. 4 through 6.

[0030] As shown in Figs. 4 through 6, as the rotation shaft 2 is rotated once to compress the closing spring, the cam 4 rotates while being contacted by the cam follower 55 of the working lever 53.

[0031] Here, in an orientation as shown in Fig. 4 where the cam follower 55 of the working lever 53 contacts the first surface portion 42 of the cam 4 having a large radius of curvature, the end portion 56 of the counter lever 52 is pressed upon by the one end portion 57 of the working lever 53, thereby being depressed downwardly.

[0032] Meanwhile, as shown in Fig. 5, when the cam follower 55 of the working lever 53 encounters the second surface portion 41 of the cam 4 having a smaller radius of curvature, the working lever 53 pivots in a clockwise direction and the one end portion thereof 57 moves upwardly. Accordingly, the counter operating lever 52 which is elastically biased by the spring (not shown) to pivot in a counterclockwise direction pivots in a counterclockwise direction, and the end portion 56 of the counter operating lever 52 rises upwardly.

[0033] Meanwhile, as the cam 4 rotates further in a clockwise direction as shown in Fig. 6, and when the cam follower 55 of the working lever 53 is returned to a contact position on the first surface portion 42 of the cam 4 having a large radius of curvature, the working lever 53 pivots in a counterclockwise direction and the end portion 57 thereof moves downwardly. Accordingly, the end portion 56 of the counter operating lever 52 is pressed by the end portion 57 of the working lever 53 as it moves downwardly, and pivots in a clockwise direction, thereby displacing downwardly.

[0034] According to such repeated up and down rotations of the counter operating lever 52, the drive shaft 51a of the mechanical counter 51 is incrementally rotated by operation of a ratchet and pawl mechanism (not shown). Accordingly, the numeric dials (not shown) within the mechanical counter 51 are rotated incrementally, thereby counting the number of times the contacts of the air circuit breaker have been closed.

[0035] That the contacts of the air circuit breaker have been closed can signify switching operation from circuit opening to circuit closing. The number of times the circuit is opened is considered to be the same as the number of times a circuit is closed. Therefore, the number of times a circuit of the air circuit breaker is closed multiplied by 2 would make the total sum of the number of times a circuit of the air circuit breaker is closed and opened. Thus, using the number of times, displayed by the mechanical counter 51, the air circuit breaker is closed, a user may recognize the number of times of a circuit being closed, the number of times of a circuit being opened and the total sum thereof.

[0036] Configured and operated as described above, the operation counter driving apparatus 5A of the air circuit breaker according to the first embodiment of the present invention contacts the cam 4 mounted at the rotation shaft 2 with a cam follower of the working lever while the shaft 2 is being rotated to compress the closing spring, and the displacement of the working lever corresponds with its contact position on the outer circumferential surface of the cam 4. Accordingly, the force caused by a sharp tension of the closing spring is buffered by being progressively transferred by the cam surface of the cam 4, thereby preventing damage of components (e.g., the counter operating lever 52, the working lever 53, etc.) of the operation counter driving apparatus 5A without impacting thereon.

[0037] Further, since the counter operating lever 52 or the working lever 53 can be prevented from being bent or damaged, the operation of counting and displaying the number of times a circuit is opened/closed can be accurately performed in a stable state. Therefore, since a user may accurately recognize, with reliability, the number of times a circuit is opened/closed, it is effective to enable recognition of when maintenance is necessary in order to prevent accidents in power distribution system due to the deterioration of the air circuit breaker.

[0038] Next, a operation counter driving apparatus for an air circuit breaker according to a second embodiment of the present invention will be described in detail.

[0039] The operation counter driving apparatus of the air circuit breaker according to the second embodiment of the present invention has many things in common with the operation counter driving apparatus 5A for an air circuit breaker according to the first embodiment of the present invention. The most basic but distinguished feature of the present invention is as follows: a large force generated when the closing spring is charged through the rotation shaft 2, is buffered through the cam to transferred to other components of the operation counter driving apparatus. In addition to such basic common features, the working lever for transferring force required to drive the counter while pivoting according to its contact location on the outer circumferential cam surface of the cam, the four phases of the counter operating lever and the mechanical counter are supported and maintained by the support bracket fixed to the side plates 6.

[0040] Meanwhile, differences in the structure between the operation counter driving apparatus described in the first embodiment and the operation counter driving apparatus for an air circuit breaker according to the second embodiment of the present invention will be described briefly.

[0041] The operation counter driving apparatus 5B for an air circuit breaker according to the second embodiment of the present invention has the following differences from the operation counter driving apparatus 5A according to the first embodiment: First, the cam 7 is coaxially mounted on an end of the rotation shaft 2 so as to be exposed outside of the side plate 6 of the switching unit 3. Second, the working lever 53 is pivotally supported by the pivot pin 63 fixed to the side plate 6. Third, the working lever 53 has a unique structure for interconnecting the working lever 53 and the counter operating lever 52.

[0042] Hereinafter, the structure and operation of the operation counter driving apparatus 5B of the air circuit breaker according to the second embodiment of the present invention will be described in detail with reference to the accompanying drawing.

[0043] In an implementation of the operation counter driving apparatus 5B for an air circuit breaker according to the second embodiment of the present invention as shown in Figs. 7 through 11, the air circuit breaker includes a switching unit 3, which provides a driving force to perform an opening or closing operation of contacts, and is supported by a pair of side plates 6 at respective sides thereof. A charging handle 1 for manually charging a closing spring (not shown) is rotatably mounted at one side of the switching unit 3. The operation counter driving apparatus 5B of the air circuit breaker according to the second embodiment of the present invention is supported by a support bracket 60 at the other side of the switching unit 3. Reference numeral 2 denotes a rotation shaft, which is directly or indirectly connected to a rotation shaft (not shown) of the handle 1 or a rotation shaft of a motor (not shown) so as to charge an elastic potential energy in the closing spring, and provides a rotation force for charging an elastic potential energy in the closing spring.

[0044] As shown in Figs. 7 and 8, the operation counter driving apparatus 5B includes a cam 7 coaxially connected to the rotation shaft 2, and having an outer circumferential surface as a cam profile surface with a varying radius of curvature, for buffering and transferring the rotation force of the rotation shaft 2. The outer circumferential surface of the cam 7 includes a first surface portion 7a having a large radius of curvature, and a second surface portion 7b having a smaller radius of curvature compared to that of the first surface 7a, almost like a flat plane. The profile of the cam 7 is not limited to those described in reference to the embodiments shown in Figs. 7 through 11, but may have variously modified profiles under a condition that an outer surface has a cam profile surface with a varying radius of curvature (i.e., a surface portion with an increasing radius of curvature and a surface portion with a decreasing radius of curvature).

[0045] As shown in Figs. 7 and 8, the counter apparatus 5B according to the second embodiment of the present invention includes, in addition to the cam 7, a working lever 53 having a cam follower portion contacting the outer circumferential surface of the cam 7 and pivoting according to its contact position on the outer circumferential surface of the cam 7. The working lever 53 is pivotally supported at the side plate 6 by the pivot pin 63. Similar to the first embodiment of the present invention, an end portion of the pivot pin 63 extending inside the side plate 6 may be fixed by a fixing pin or clip (not shown) so as to prevent its separation in the axial direction. In the same way, the detailed structure of the pivot pin 63 may be the same as that of the pivot pin 54 described in the first embodiment, or the pivot pin may be replaced with a rivet.

[0046] The mechanical counter 51, which is the same as that in the first embodiment, and can be supported by the support bracket 60 which is formed in an "L" shape and fixed to the side plate 6.

[0047] The operation counter driving apparatus 5B further includes the mechanical counter 51 for counting and displaying the number of times a circuit of the air circuit breaker has been closed. The mechanical counter 51 includes a drive shaft (not shown) for receiving driving force for operating thereof.

[0048] The operation counter driving apparatus 5B further includes a counter operating lever 52 connected at one end to the drive shaft of the mechanical counter 51, having another end for contacting the working lever 53, and pivoting by cooperative arrangement with the working lever 53, for thereby transferring a driving force to the drive shaft of the counter 51 to count and display the number of times the circuit of the air circuit breaker has been closed.

[0049] Fig. 8 is a perspective view showing main components of the operation counter driving apparatus for an air circuit breaker according to the second embodiment of the present invention.

[0050] Referring to Fig. 8, the components of the op-

eration counter driving apparatus according to the second embodiment of the present invention will be described in detail from left to right.

[0051] In Fig. 8, first, a pair of closing spring charging cams 2a located inside a switching unit 3 between the side plates 6, which are omitted in Fig. 8 for convenience, are mounted at the central portion of the rotation shaft 2 and spaced apart axially. The cam 7 included in the operation counter driving apparatus according to the present invention, and buffering/transferring the driving force applied to the operation counter driving apparatus, is mounted at one end portion of the rotation shaft 2 protruding outside of the side plate 6.

[0052] The outer circumferential surface of the cam 7 includes the first surface portion 7a having a large radius of curvature, and a second surface portion 7b having a smaller radius of curvature when compared to that of the first surface 7a, almost like a flat plane.

[0053] The working lever 53 is an approximately "L"-shaped lever, and includes a central pivot portion 53a for being rotatably supported by the pivot pin 63 serving as a pivot axis at the side plate 6, a first portion 53b extending in one direction from the rotation central portion 53a and contacting the outer circumferential surfaces portions 7a and 7b of the cam 7, a second portion 53c extending in another direction from the rotation central portion 53a, and a pair of leg portions 53d disposed at an end of the second extending portion 53c and having an elongate groove 53e therebetween. The working lever 53 can pivot according to its contact position on the outer circumferential surface of the cam.

[0054] Here, preferably, the end portion of the first extending portion 53b contacting the outer circumferential surfaces portions 7a and 7b of the cam 7 is formed as a cam follower having a rounded surface to reduce friction.

[0055] Same as the pivot pin 54 of the first embodiment of the present invention, the pivot pin 63 includes a head portion, a body portion having a diameter smaller than the head portion and a smooth circumferential surface and providing a pivot support point of the working lever 53, and a leg portion having an externally threaded surface for being threaded into a mounting hole (not shown) of the side plates 6.

[0056] In addition, similarly to the first embodiment of the present invention, the leg portion protrudes through mounting hole in the side plate 6 such that an end portion of the pivot pin 63 protruding toward an inside of the side plate 6 (i.e., inside the switching unit 3) can be restricted s by a fixing pin (not shown) or clip so as to prevent the separation of the pivot pin 63 in its axial direction.

[0057] Alternatively, a structure may be implemented in a manner that the pivot pin 63 may be replaced with a rivet without any threaded portion, and an end portion of the rivet protruding toward the inside of the side plate 6 through the mounting hole may be expanded, compressed or flattened, thereby preventing movement in the axial direction.

[0058] The support bracket 60 is an approximately "L" shape plate, formed of two perpendicular plate portions consisting of a long plate portion and a short plate portion. The mechanical counter 51 is fixed to the long plate portion by a fixing means, such as bolts and nuts (not shown). A rectangular-shaped opening is disposed at the long plate portion such that the leg portion 53d of the working lever 53 can penetratingly extend therethrough to contact the counter operating lever 52. The mounting hole are disposed in the short plate portion of the support bracket 60 so as to accept fixing means (e.g., screw or bolt) for being fixed to the side plate 6.

[0059] Numeric dials (not shown) for displaying a count tally and a drive shaft (not shown) as a rotation shaft of such numeric dials are provided inside the mechanical counter 51. Also, the mechanical counter 51 includes an outer case for accommodating and protecting such numeric dials. As shown in Figs. 7 and 11, upper and lower portions of the outer case are provided with mounting flanges or lugs having holes (not shown) therein through which fixing means can be inserted for fixing to the support bracket 60.

[0060] The counter operating lever 52 is connected to the drive shaft of the mechanical counter 51. Preferably, the end portion 52a, which contacts the pair of leg portions 53d of the working lever 53, is formed to have a rounded surface to reduce friction.

[0061] With such configurations, the operation of the operation counter driving apparatus 5B of the air circuit breaker according to the second embodiment of the present invention will be described in detail with reference to Figs. 9 through 11.

[0062] Referring to Figs. 9 through 11, as the rotation shaft 2 is rotated once to compress the closing spring, the cam 7 rotates while being contacted by the cam follower end portion of the first extending portion 53b of the working lever 53.

[0063] Here, if the cam follower end portion of the first extending portion 53b of the working lever 53 as shown in Fig. 9 contacts the first surface portion 7a of the cam 7 having a large radius of curvature, and as the working lever 53 rotates in a counterclockwise direction, both of the leg portions 53d of the working lever 53 move downwardly. Accordingly, the end portion 52a of the counter operating lever 52 is located in a lower portion of the elongate groove 53e between the leg portions 53d of the working lever 53. And simultaneously, the counter operating lever 52 pivots in a clockwise direction and the end portion 52a of the counter lever 52 moves downwardly.

[0064] Meanwhile, if the cam follower end portion of the first extending portion 53b of the working lever 53 contacts the second surface portion 7b of the cam 4 having a smaller radius of curvature like almost a plane as shown in Fig. 10, the working lever 53 pivots in a clockwise direction, and both of the leg portions 53d move upwardly. Accordingly, the end portion 52a of the counter operating lever 52 is located at an upper portion of the elongate groove 53e between both of the leg portions 53d of the working lever 53. And simultaneously, the

counter operating lever 52 pivots in a counterclockwise direction and the end portion 52a of the counter operating lever 52 moves upwardly.

[0065] Meanwhile, as the cam 7 rotates further in a clockwise direction as shown in Fig. 11, and if the cam follower end portion of the first extending portion 53b of the working lever 53 is located at a position rotated further in a clockwise direction while contacting the second surface portion 7b of the cam 7 having a smaller radius of curvature, the working lever 53 pivots in a clockwise direction, and the cam follower end portion of the first extending portion 53b moves more upwardly.

[0066] Therefore, the end portion 52a of the counter lever 52 is located at the upper portion of the elongate groove 53e between both of the leg portions 53d of the working lever 53. And simultaneously, the counter operating lever 52 pivots further in a counterclockwise direction, thereby making the end portion 52a of the counter operating lever 52 move upwardly more.

[0067] Meanwhile, as shown in Fig. 9, as the cam 7 rotates further in a clockwise direction, and if the cam follower end portion of the first extending portion 53b of the working lever 53 is returned to the position contacting the first surface portion 7a of the cam 7 having a large radius of curvature, as described with reference to Fig. 9, then the end portion 52a of the counter operating lever 52 finally moves downwardly.

[0068] According to repeated application of operating strokes to the counter operating lever 52 and moving upward/downward displacement of the end portion 52a, the drive shaft of the counter 51 is rotated. Accordingly, the numeric dials (not shown) in the counter 51 rotate, thereby counting the number of times a circuit of the air circuit breaker is closed.

[0069] That the air circuit breaker is closed can signify switching from circuit opening to circuit closing. The number of times a circuit is opened is considered to be the same as the number of times a circuit is closed. Therefore, the number of times a circuit of the air circuit breaker is closed multiplied by 2 would make the total sum of the number of times a circuit of the air circuit breaker is closed and opened. Thus, using the number of times, displayed by the mechanical counter 51, the circuit of the air circuit breaker is closed, a user may recognize the number of times of a circuit being closed, the number of times of a circuit being opened and the total sum thereof.

[0070] Configured and operated as described above, the operation counter driving apparatus 5B for an air circuit breaker according to this second embodiment of the present invention contacts the cam 7 mounted at the rotation shaft 2 while being rotated to compress the closing spring, and operates in accordance with a contact position on the outer circumferential surface of the cam 7. Accordingly, the force caused by a sharp tension of the closing spring is buffered by being progressively transferred by the cam surface of the cam 7, thereby preventing damage to components (e.g., the counter operating lever 52, the working lever 53, etc.) of the operation counter driving apparatus 5B without impacting thereon.

[0071] Since the counter operating lever 52 or the working lever 53 can be prevented from being bent or damaged, the operation of counting and displaying the number of times a circuit is closed/opened can be accurately performed in a stable state. Therefore, since a user may accurately recognize, with reliability, the number of times a circuit is closed/opened, it is effective to enable recognition of when service is due so as to prevent accidents in power distribution system due to the deterioration of the air circuit breaker.

[0072] Further, the operation counter driving apparatus 5A or 5B for the air circuit breaker according to the present invention can be easily mounted through the support bracket to the side plates 6 supporting the switching unit 3, enabling an easy mounting to and separation from the air circuit breaker.

[0073] As the present features may be embodied in several forms without departing from the characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalents of such metes and bounds are therefore intended to be embraced by the appended claims.

Claims

1. In an air circuit breaker, which includes a rotation shaft, and a closing spring for charging an elastic potential energy by a rotation force of the rotation shaft, and which closes a circuit by using the elastic potential energy charged in the closing spring, an operation counter driving apparatus, comprising:

   a cam coaxially connected to the rotation shaft, and having an outer circumferential surface formed with a cam profile with a varying radius of curvature, for buffering and transferring the rotation force of the rotation shaft to a mechanical counter to count the number of times the circuit of the air circuit breaker is closed.

2. In an air circuit breaker, which comprises a rotation shaft, and a closing spring for charging therein elastic potential energy by a rotation force of the rotation shaft, and which closes a circuit by using the elastic potential energy charged in the closing spring, an operation counter driving apparatus, comprising:

   a cam coaxially connected to the rotation shaft so as to be rotatable with the rotation shaft, and having an outer circumferential surface formed with a cam profile with a varying radius of cur-

vature, for buffering and transferring the rotation force of the rotation shaft;
a working lever having a portion contacting the outer circumferential surface of the cam, and pivoting according to a contact position thereof on the outer circumferential surface of the cam;
a mechanical counter having a drive shaft for receiving power for counting; and
a counter operating lever connected to the drive shaft of the counter, having one end contacting the working lever, and pivoted by engagement with the working lever, thereby transferring a driving power to the drive shaft of the counter to count and display the number of times the circuit of the air circuit breaker is closed.

3. The apparatus of claim 2, wherein the working lever is provided with a protruding cam follower portion contacting the outer circumferential surface of the cam.

4. The apparatus of claim 3, wherein the protruding cam follower portion of the working lever, contacting the outer circumferential surface of the cam, is formed to have a round shape.

5. The apparatus of claim 2, further comprising:

a support bracket for supporting the counter and the working lever,

wherein a shaft hole is formed in one end of the working lever, and the working lever is pivotally supported at the support bracket by a pivot pin, which penetrates the shaft hole and is fixed to the bracket.

6. The apparatus of claim 2, wherein the end portion of the counter lever contacting the working lever is formed to have a rounded surface.

7. In an air circuit breaker, which includes a rotation shaft, and a switching unit having a closing spring for charging elastic potential energy by a rotation force of the rotation shaft, and which closes a circuit by using the elastic potential energy charged in the closing spring, an operation counter driving apparatus, comprising:

a cam coaxially connected to the rotation shaft so as to be rotatable with the rotation shaft, and having an outer circumferential surface formed with a cam profile with a varying radius of curvature, for buffering and transferring the rotation force of the rotation shaft;
a working lever having a central portion pivotally supported by a pivot pin at a side plate, a first extending portion extending from the central portion in one direction and contacting the outer circumferential surface of the cam, a second extending portion extending from the central portion in another direction, and a pair of leg portions disposed at an end of the second extending portion and having an elongate groove therebetween, and pivoting according to a contact position thereof on the outer circumferential surface of the cam;
a mechanical counter for counting the number of times the circuit of the air circuit breaker is closed; and
a counter operating lever connected between the counter and the working lever, having a portion contacting the pair of leg portions in the elongate groove of the working lever, and pivoting by engagement with the working lever, for thereby transferring a driving force to the counter to count and display the number of times the circuit of the air circuit breaker is closed.

8. The apparatus of claim 7, wherein a portion of the counter lever contacting the leg portion is a protruding portion, and a surface thereof contacting the leg portion is rounded.

9. The apparatus of claim 7, wherein an end of the first extending portion of the working lever contacting the outer circumferential surface of the cam is formed with a rounded surface.

FIG. 1

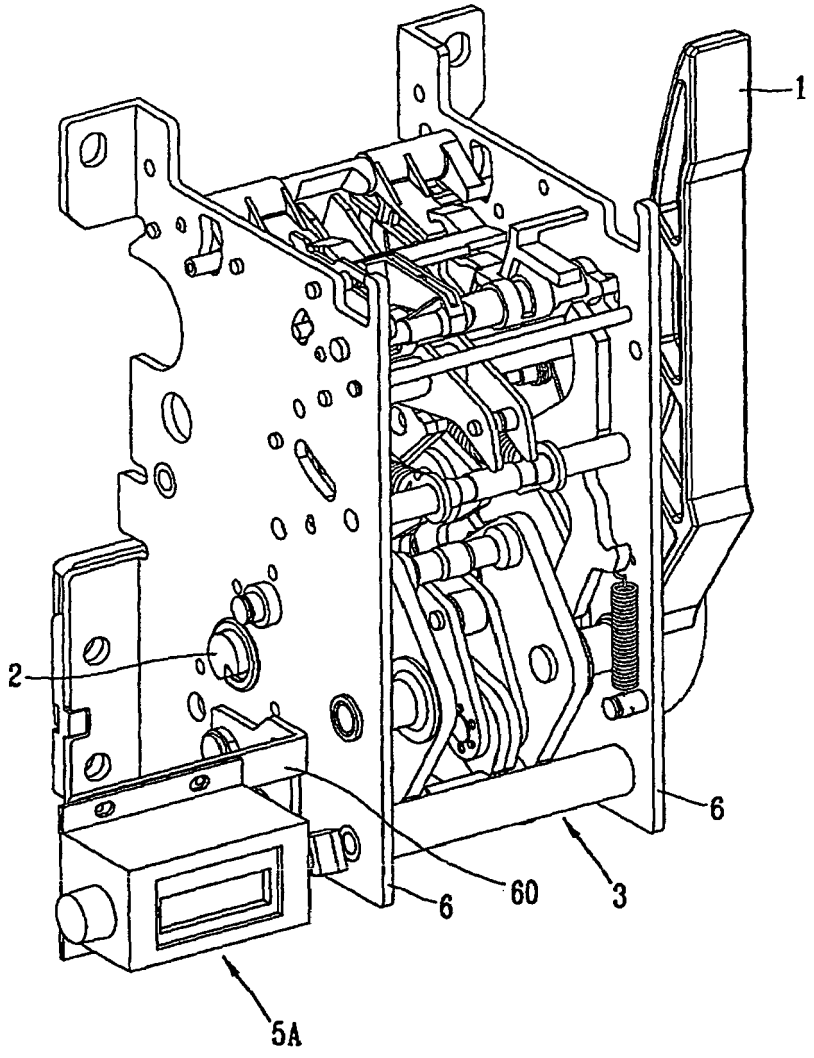

FIG. 2

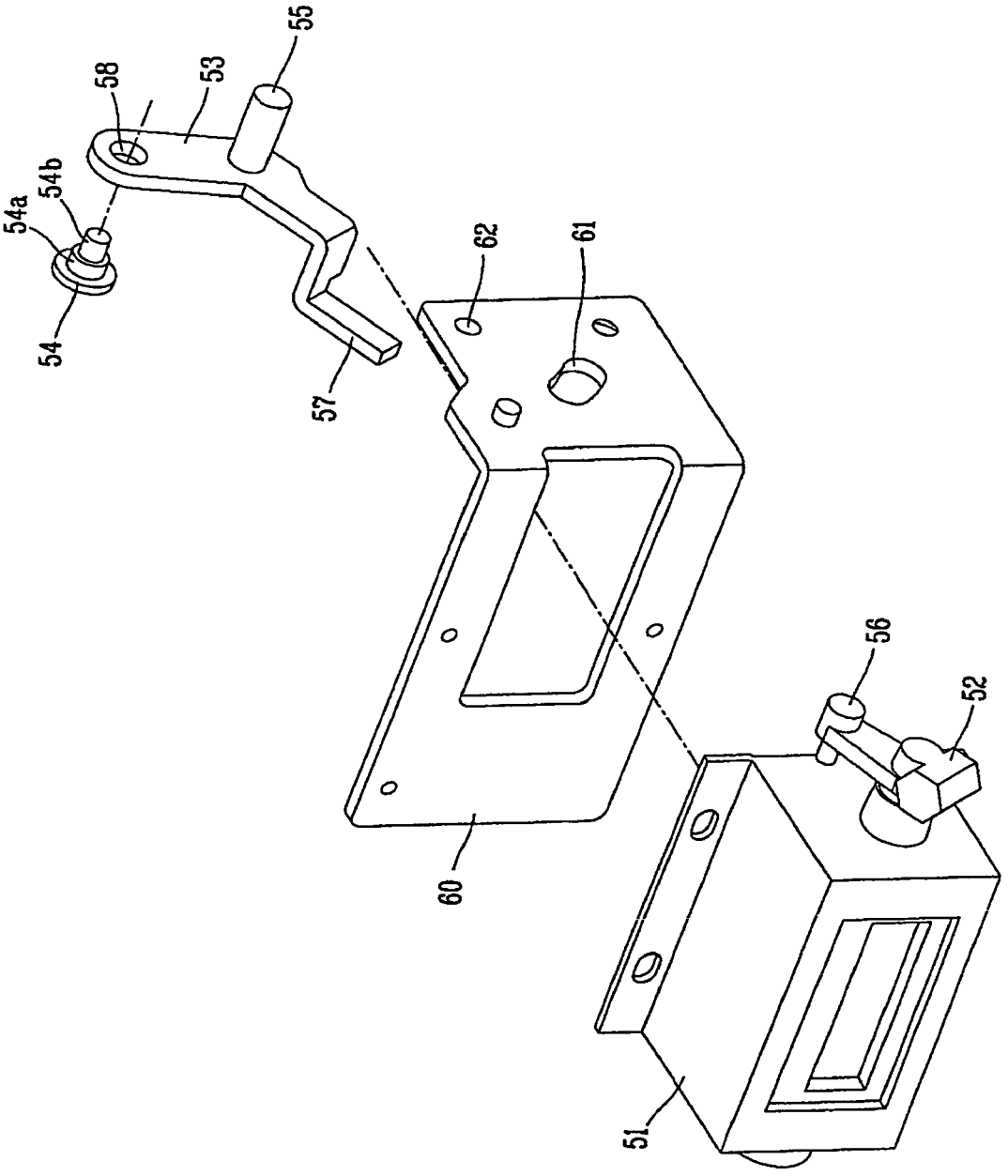

FIG. 3

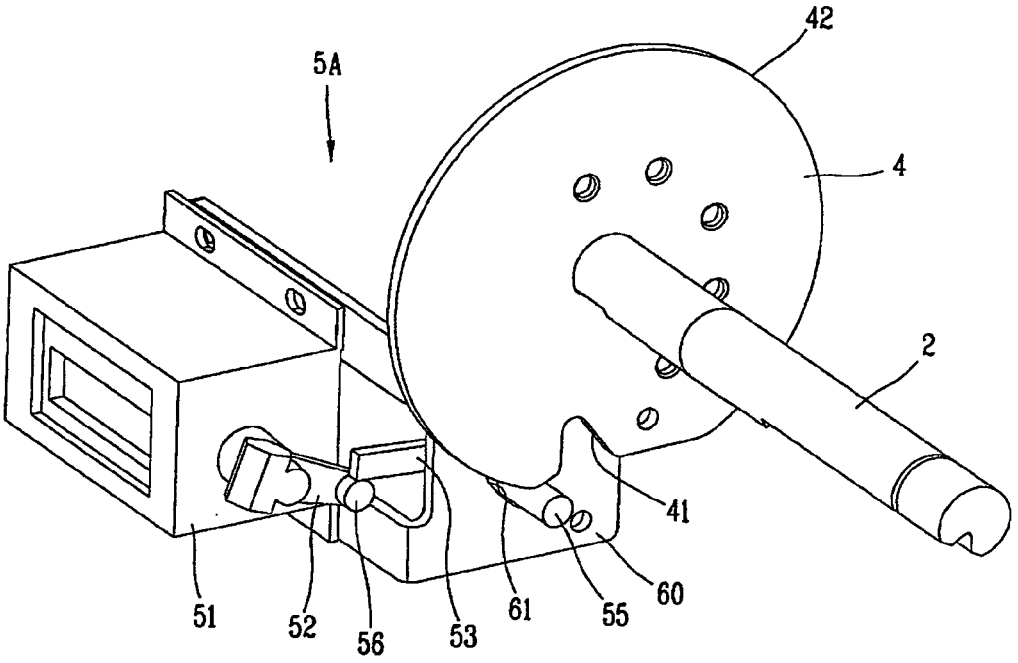

FIG. 4

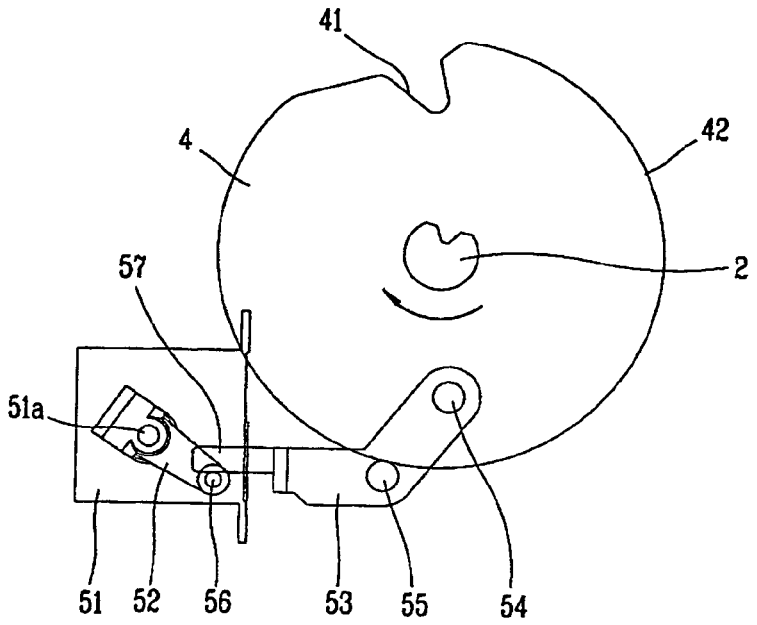

FIG. 5

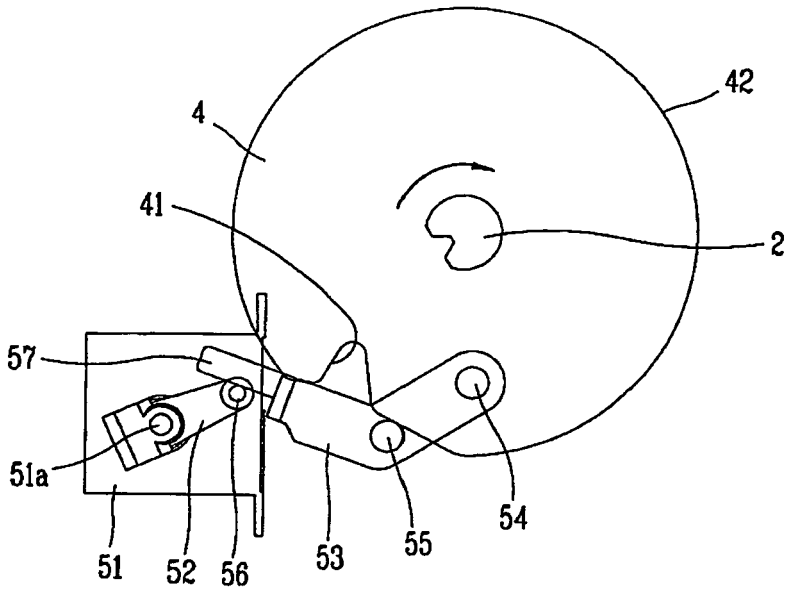

FIG. 6

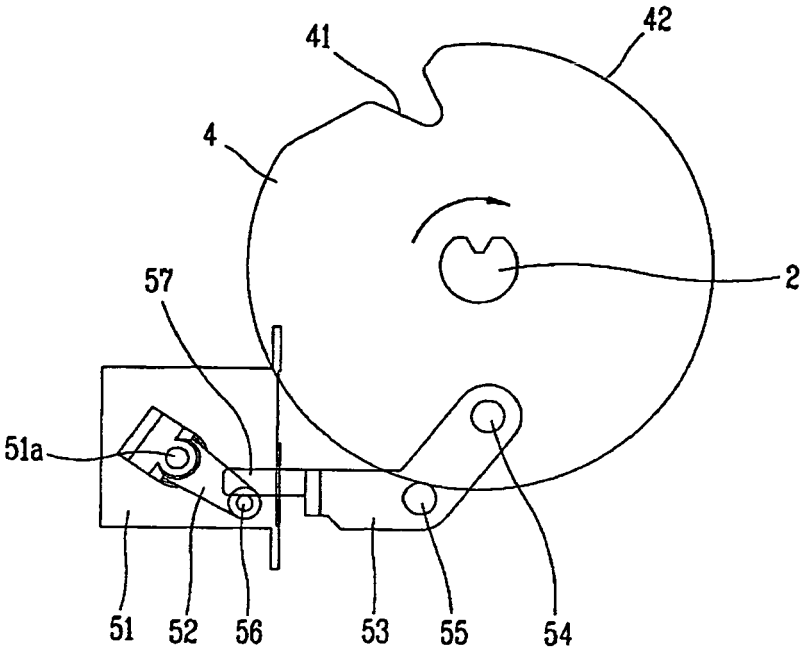

FIG. 7

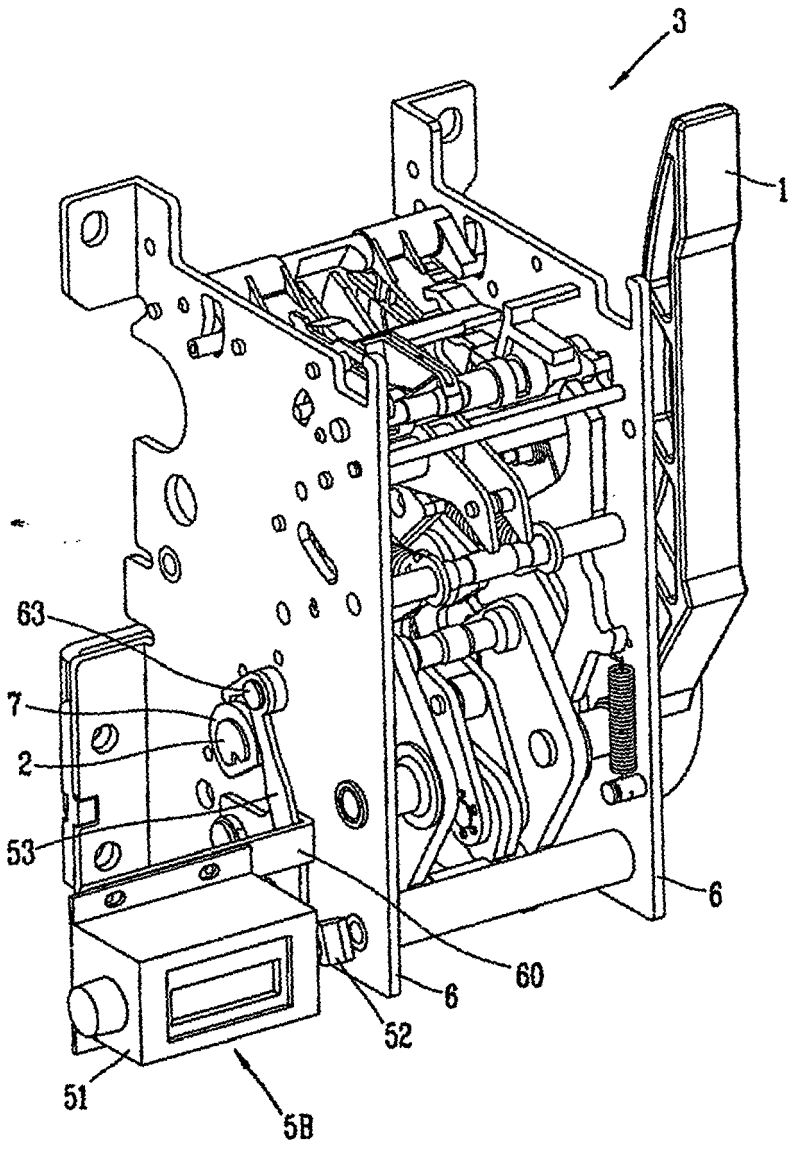

FIG. 8

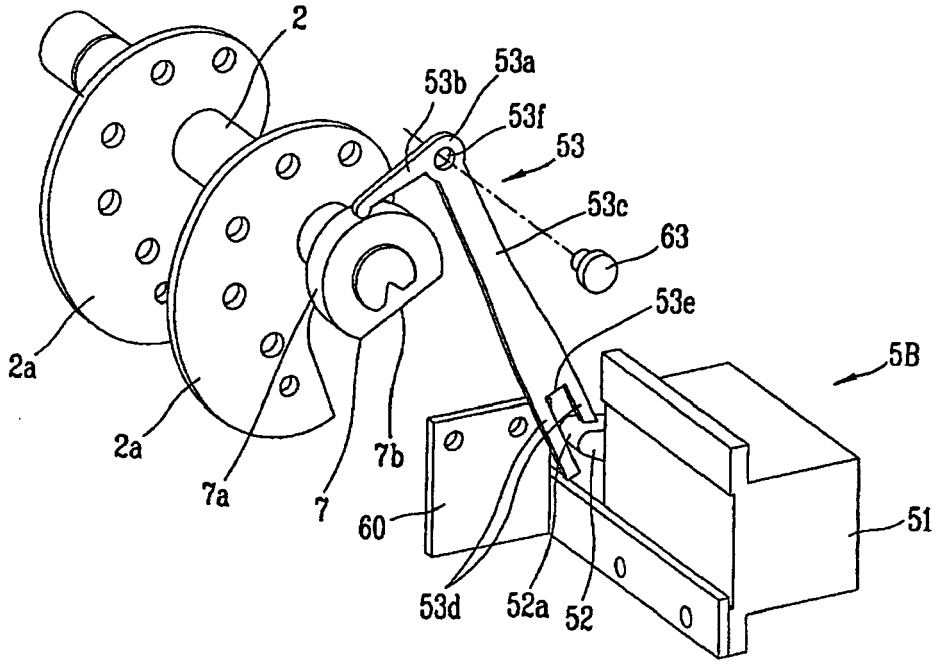

FIG. 9

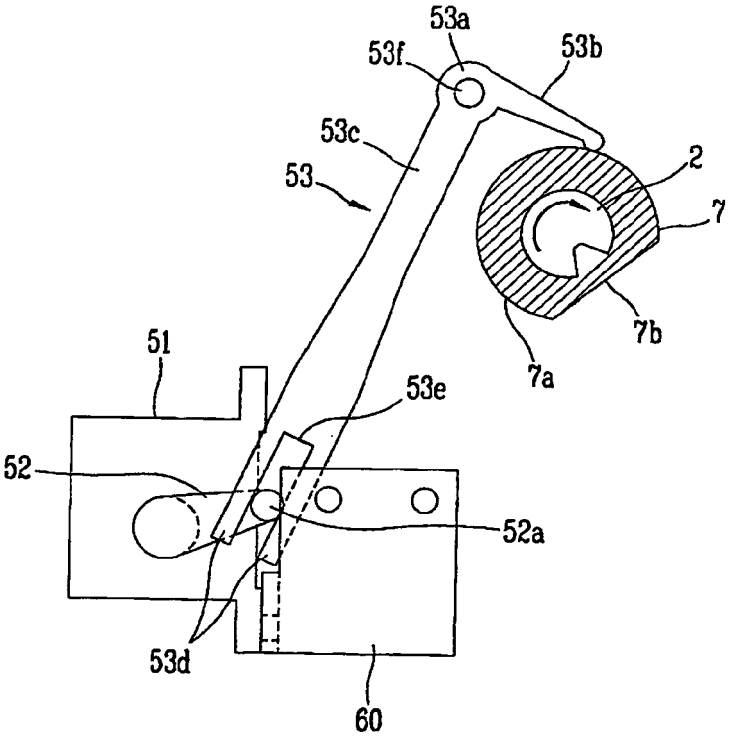
53a
53f
53b
53c
53
2
7
7b
7a
51
53e
52
52a
53d
60

FIG. 10

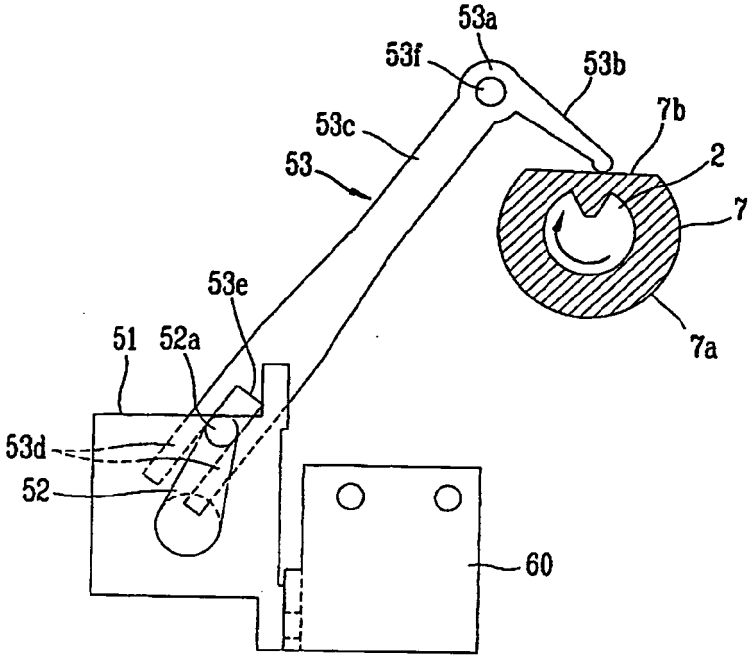
53a
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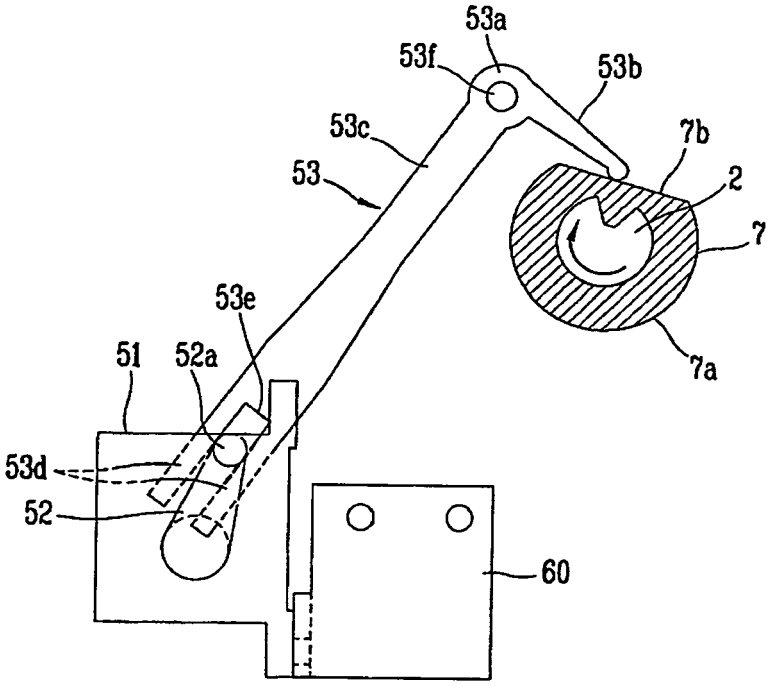
FIG. 11



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 01 9937

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 3 858 133 A (RUDY R ET AL) 31 December 1974 (1974-12-31) * column 3, lines 49-60; figure 1 * -----	1-9	INV. H01H3/30
A	US 4 095 676 A (HOWE FRANCIS M ET AL) 20 June 1978 (1978-06-20) * column 2, lines 60-68; figure 3 * -----	1-9	

TECHNICAL FIELDS SEARCHED (IPC)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	7 January 2008	Simonini, Stefano

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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07-01-2008

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