

A ROTARY ADAPTOR WITH DECELERATING MECHANISM

FIELD OF THE INVENTION

5 The present invention broadly relates to an adaptor between a switching device and an electrical device, and particularly relates to a rotary adaptor with decelerating (or damping) mechanism used for a circuit breaker or the like.

10 BACKGROUND OF INVENTION

 A switching device to operate an electrical device such as a circuit breaker or the like is typically mounted outside a chassis encasing the electrical device to operate the
15 device. The switching device is mechanically connected to a lever of the electrical device which is placed in the chassis. This way, the electrical device can be operated without having to open the chassis; therefore making it possible to operate the electrical device safely.

20 A patent application US 2008/0135389 A1 published on 12 June 2008 reveals an extended actuating device, which makes it possible to remote control an electrical device, more specifically a circuit breaker. The extended actuating device operates in two modes and is connected between a switching
25 device and a circuit breaker. In the first mode, by turning the switching device, a driving force causes movement of a lever (or knob) of the circuit breaker by intermediary of a transmission shaft. In the second mode, when the circuit breaker is tripped due to, for example, a current overload or
30 a short circuit, this causes movement of the lever from a "CLOSE" position to a "TRIPPED" position and drives the transmission shaft. The switching device follows the movement imparted by the lever to a "TRIPPED" indication. In order for

the lever to deliver a large enough driving force to the transmission shaft and ultimately to the switching device, the extended actuating device utilizes a tripping assistance mechanism (TAM), which works as an amplifier.

5 However, the introduction of the TAM would, in turn, require a user, when closing the circuit breaker by turning the switching device, to exert a larger force in order to overcome the resistance of the TAM.

10 A larger force can be achieved by simply having the user apply more physical strength to turn the switching device to the desired position. However, more than often, to achieve a larger force, the user tends to turn the switching device in fast motion so that the momentum in turning is used, usually in addition to physical strength, in a bid to overcome the
15 resistance of the TAM.

 When exerting the larger force, which is beyond a certain amount in fast motion on the switching device, the circuit breaker is highly unlikely to be able to maintain at the "CLOSE" position. This is because exerting a force beyond this
20 amount in fast motion results in high velocity of the lever, which in turn causes high acceleration of a moving contact of the circuit breaker to hit and bounce off a stationary mating contact at the "CLOSE" position due to inherent elasticity of the contacts. This is commonly known as contact bounce.

25 In this case, the high accelerations cause a high degree of bouncing off, thereby preventing mating or even latching of the contacts at the "CLOSE" position. As such, the circuit breaker fails to close, and a false indication of closure to the user is presented.

30 A permanent friction can be applied on the TAM at the "CLOSE" position to allow the circuit breaker's knob axle to maintain the "CLOSE" position. However, this would completely desensitize the TAM from responding to the circuit breaker's

tripping operation, and defeat the purpose of the TAM in the first place.

Therefore, there is a need for an improved mechanism to address the problem mentioned above.

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SUMMARY OF INVENTION

A rotary adaptor with decelerating mechanism for connection to a complementary device comprising a body, and at least one arm
10 having one end configured to couple to the body, the at least one arm movable between a first position and a second position, wherein in the first position, the at least one arm is retracted, and in the second position, the at least one arm is expanded outwardly with the other end of the at least one arm configured
15 to contact a surface of the complementary device to provide interfacial friction.

In use, when the rotary adaptor is rotating at an angular velocity of more than or equal to a threshold, the at least one arm expands outwardly to the second position, wherein the other
20 end of the at least one arm contacts and rubs against the surface of the complementary device to provide interfacial friction and cause decelerating of the rotary motion.

When the rotary adaptor experiences decelerating rotation due to interfacial friction, the at least one arm retracts from
25 the second position toward the first position; thereby allowing the other end of the at least one arm to reduce contacting and rubbing against the surface of the complementary device to reduce interfacial friction.

When the rotary adaptor decelerates due to reduced
30 interfacial friction and rotates at an angular velocity of less than the threshold, the at least one arm retracts toward the first position to a point where interfacial friction is removed.

The complementary device may comprise a circuit breaker or a retaining bracket having an aperture.

The one end of the at least one arm may be pivotably coupled to the body by a pin, the pin being receivable in a recess provided by the rotary pin. The at least one arm may be held in the first position by a spring. The spring may be
5 arranged between the one end of the at least one arm and the body. The at least one arm of the rotary adaptor may comprise two or more arms.

An assembly comprising a circuit breaker comprising a knob, a tripping assistance mechanism (TAM) arranged to couple to the
10 circuit breaker at its knob axle via a rotary adaptor with decelerating mechanism, a retaining bracket encasing the rotary adaptor, and a switching device comprising a transmission shaft coupled to the TAM.

15 **BRIEF DESCRIPTION OF THE DRAWINGS**

Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, with
20 reference to the accompanying drawings, in which:

Figure 1 shows an exploded perspective view of an assembly for a known circuit breaker employing a TAM;

Figure 2 shows a front expanded view of a known simple
25 adaptor 14 of Figure 1;

Figure 3 shows an exploded perspective view of an assembly of a circuit breaker employing an embodiment of the invention;

Figure 4 shows a front expanded view of the embodiment of
30 Figure 3;

Figure 5(a) shows a perspective view of the embodiment of Figure 4 in its assembled configuration;

Figure 5(b) shows a perspective view of the embodiment of Figure 4 in a configuration depicting assembly parts (partially exploded);

5 Figure 5(c) shows a snapshot front view of the embodiment of Figure 4, in a configuration where the movements of the assembled parts are limited to prevent damage of the embodiment;

10 Figure 6(a) shows a snapshot front view of (i) the embodiment of Figure 4 and (ii) the embodiment of Figure 4 in the partial assembly of Figure 3, rotating at an angular velocity of less than a threshold T ;

15 Figure 6(b) shows a snapshot front view of (i) the embodiment of Figure 4 and (ii) the embodiment of Figure 4 in the partial assembly of Figure 3, rotating at an angular velocity of more than or equal to the threshold T ;

Figure 7(a) shows a front view of a second embodiment of the invention.

Figure 7(b) shows a front view of a third embodiment of the invention.

20 Figure 8(a) shows a front view of a fourth embodiment of the invention.

Figure 8(b) shows a front view of a fifth embodiment of the invention.

25 Figure 9 shows a snapshot front view of (a) a sixth embodiment of the invention, rotating at an angular velocity of less than a threshold T ; (b) the sixth embodiment rotating at an angular velocity of more than or equal to the threshold T ; and (c) the sixth embodiment experiencing decelerating or damping rotation.

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DETAILED DESCRIPTION

With reference to the drawings, Figure 1 shows an assembly 10 (in an exploded view) comprising a circuit breaker

12 with its knob 13 connected at its knob axle to a simple adaptor 14, which is encased within a retaining bracket 16. The retaining bracket 16 comprises an aperture 17 through which the simple adaptor 14 is connected to a TAM 18, the TAM 5 18 comprising a transmission shaft 19 connected to a switching device (not shown in Figures). The circuit breaker 12 typically with a weak tripping torque requires the TAM 18 in the assembly 10 to provide a true and well-positioned "TRIPPED" indication of the switching device when the circuit 10 breaker 12 is tripped with its knob 13 at a "TRIPPED" position. The working principle of a TAM is known in the art.

Figure 2 shows the simple adaptor 14 comprising a body 20 and a protrusion 22. The body 20 of the simple adaptor 14 may be made of monolithic plastic. The body 20 is attachable or 15 shaped to be fit-attachable to the knob 13 of the circuit breaker 12. The protrusion 22, comprising a female mating groove 24, is positioned along the body 12 so that the female mating groove 24 is configured to couple to the TAM 18.

The circuit breaker 12 is switchable between the 20 "TRIPPED" position and a "CLOSE" position. When the circuit breaker 12 is tripped due to, for example, a current overload or a short circuit, the circuit breaker 12 originally at the "CLOSE" position is switched to the "TRIPPED" position. At the same time, by an enhanced tripping torque from the TAM 18, the 25 switching device also turns to the "TRIPPED" indication.

For a user to rotate the switching device (not shown in Figures) to switch the circuit breaker 12 from the "TRIPPED" position back to the "CLOSE" position, a large turning force is required to overcome a resistance of the TAM 18. Often, the 30 user tends to turn the switching device in fast motion so that the momentum in turning is used, usually in addition to physical strength, in a bid to overcome the resistance of the TAM 18.

Turning of the switching device in fast motion leads to a high angular velocity of the knob 13, which translates to high acceleration of a moving contact of the circuit breaker 12. The moving contact hits and subsequently bounces off a
5 corresponding stationary mating contact at the "CLOSE" position due to inherent elasticity of the switch contacts.

In the assembly 10, if the acceleration is less than a certain level, the degree of bouncing off experienced by the moving contact is minimal; hence the moving contact is
10 nonetheless able to maintain eventual contact with the stationary mating contact and the circuit breaker 12 is closed. However, if the acceleration is equal to or beyond this level, the moving contact bounces off the stationary contact more significantly and would not be able to maintain
15 contact with the stationary mating contact. In other words, the circuit breaker 12 cannot maintain at the "CLOSE" position as it fails to close. This results in an offset of the switching device from a "CLOSE" indication. However, the offset may not be significant or apparent, and this gives a
20 false "CLOSE" indication to the user.

In an assembly 30 (in an exploded view) of Figure 3, an embodiment of the invention provides an adaptor with decelerating (or damping) mechanism for a circuit breaker 32 in place of the simple adaptor 14 (Figure 1). In this
25 embodiment, the adaptor is a rotary adaptor 34 connected to the circuit breaker 32 at its knob axle, and encased within a retaining bracket 36. The retaining bracket 36 comprises an aperture 37 through which the rotary adaptor 34 is connected to a TAM 38, the TAM 38 comprising a transmission shaft 39
30 connected to a switching device (not shown in Figures).

Figure 4 shows the rotary adaptor 34 comprising a body 40 and a protrusion 42. The body 40 of the rotary adaptor 34 may be made of monolithic plastic and may be formed by plastic molding or machining. The body 40 is attachable or shaped to

be fit-attachable to the knob of the circuit breaker 32. The rotary adaptor further comprises at least one arm, which is pivotable between a first position wherein the arm is retracted and a second position wherein the arm is expanded
5 outwardly. The rotary adaptor 34 in Figure 4 shows an embodiment comprising two arms 44, 46. However, the rotary adaptor may accommodate any number of arms and the number of arms is not limited to one or two. In various embodiments, the number of arms may be three, four or five.

10 In the embodiment as seen in Figure 4, the arms 44, 46 are substantially semi-circular and are contoured along the circumference of the protrusion 42. However, in a different embodiment, the arm may be of any shape and/or of any length and/or coupled to anywhere along the body, suitable for the
15 rotary adaptor to display capabilities of decelerating or damping the rotary motion. The arm may be arc-shaped. The arm may be made of metal and may be formed by metallic sintering or die casting. The metal may be sintered bronze.

The protrusion 42, comprising a female mating groove 48,
20 is positioned along the body 40 so that the female mating groove 48 is configured to couple to the TAM 38.

The body 40 of the rotary adaptor 34 further comprises protruding members 49a, 49b, 49c. The protruding members 49a, 49b, 49c are distributed along a circumferential path 400. In
25 this embodiment, each protruding member 49a, 49b, 49c is located radially at a pre-determined point, substantially equidistance R1 from the center of rotation, which is the center of the protrusion 42.

Figure 5(a) shows each of the arms 44, 46 being coupled
30 by pivoting at one end to the rotary adaptor 34 via corresponding pins 50, 52. The pin 50 is receivable by a corresponding recess 54 and the pin 52 is receivable by its corresponding recess (not shown in Figure 5(a)) provided by the rotary adaptor 34. Each recess and therefore each

corresponding arm may be located at substantially equidistance from an adjacent recess (and arm) if the number of arms and corresponding recesses are more than one.

Between the pivoted end of the arms 44 and the
5 corresponding recess 54, a spring 56 is in place to hold the arms 44 at its first retracted position. Similarly, a spring (not shown in Figure 5) is placed in between the arm 46 and its corresponding recess to hold the arm 46 at its first retracted position.

10 Figure 5(b) shows a partial exploded view of the embodiment of the rotary adaptor 34, depicting the arm 44 and the spring 56 being arranged to couple to the rotary adaptor 34 via the pin 50. The arm 46 and its corresponding spring (not shown in Figure 5(b)) are arranged with the pin 52 in the
15 same way as for the arm 44. The arm 44 is pivotable about the pin 50 and the arm 46 is pivotable about the pin 52.

Figure 5(c) shows a snapshot front view of the embodiment of the rotary adaptor 34, depicting the arms 44, 46 moving outwardly to reach the protruding members 49a, 49b, 49c at R1.

20 Each protruding member 49a, 49b, 49c is of a minimum height, in order to allow the protruding member 49a, 49b, 49c to protrude from the surface of the body 40 transversely into the path of the expanding arms 44, 46; thereby providing a block to the arms 44, 46 from expanding beyond R1. Should the arms
25 44, 46 expand outwardly beyond R1, it is highly likely that the rotary adaptor 34 would be damaged in that the spring 56 (not shown in Figure 5(c)) would be deformed and/or would be displaced from its original arrangement; thereby unable to hold the arms 44, 46 toward the first retracted position. In
30 such a case, the arms 44, 46 would not be effective and would be unable to perform their intended functions of providing deceleration to the rotary motion. This would typically occur when a user mishandles the rotary adaptor 34, more than often, by unintentional or excessive pulling of the arms 44, 46

outwardly. In this embodiment, the number of protruding members is three. In a different embodiment, there may be any number of protruding members as long as the purpose to prevent the arms from expanding outwardly beyond R1 is served.

5 Figure 6 shows snapshot front views of (i) the embodiment of the rotary adaptor 34 and (ii) the rotary adaptor 34 encased within the retaining bracket 36 when (a) the rotary adaptor 34 is rotating at an angular velocity of less than a threshold T; (b) the rotary adaptor 34 is rotating at an
10 angular velocity of more than or equal to the threshold T; and (c) the rotary adaptor 34 is experiencing decelerating or damping rotation.

 In Figure 6(a), the user turns the switching device (not shown in Figures) to the "CLOSE" indication wherein the rotary
15 adaptor 34 is allowed to rotate at the angular velocity of less than the threshold T. The arms 44, 46 experience a centrifugal force, which is an outward force away from the center of rotation. However, since this angular velocity is less than the threshold T, the resultant centrifugal force is
20 insufficient to overcome inertia mainly due to the weight of the arms and an inward resilient force of the respective springs. Therefore, each of the arms 44, 46 remains substantially at their respective first retracted positions and does not come in contact with the retaining bracket 36,
25 more specifically with its walls 60, 62 of the aperture 37.

 The threshold T is obtainable or determined by statistical studies, stimulations and/or experimental tests.

 The rotary adaptor 34 rotating at the angular velocity of less than the threshold T allows the moving contact of the
30 circuit breaker to mildly hit and minimally bounce off the stationary mating contact at the "CLOSE" position. In such a case, the moving contact makes eventual contact with the stationary mating contact, thus the switching device shows a

true and well-positioned "CLOSE" indication and the circuit breaker 32 (not shown in Figure 6(a)) is closed.

In Figure 6(b), the user turns the switching device (not shown in Figures) to the "CLOSE" indication wherein the rotary adaptor 34 is allowed to rotate at an angular velocity of more than or equal to the threshold T . The arms 44, 46 experience a centrifugal force as indicated by directional arrows 600. With this angular velocity being more than or equal to the threshold T , the resultant centrifugal force is sufficiently large to overcome the inertia due to the weight of the arms and the inward resilient force of the respective spring 56, and causes free ends of the arms 44, 46 to move outwardly to their respective second expanded positions. The free ends of the arms 44, 46 come in contact with and rub against the retaining bracket 36 at the walls 60, 62 of the aperture 37. The rubbing between the free ends of the arms 44, 46 and the walls 60, 62 causes interfacial friction, which in turn provides an opposing force on the rotary motion of the rotary adaptor 34, consequently causing the deceleration of the rotary adaptor 34 in a direction as indicated by the directional arrow 610.

With the rotary adaptor 34 decelerating, the centrifugal force is weakened and the free ends of the arms 44, 46 experience an inward retracting force mainly due to the resilience of the respective springs and the weight of the arms 44, 46.

When rotary adaptor 34 is decelerating, the arms 44, 46 slowly retract toward their first retracted positions as a result of mainly the weakened centrifugal force and the resilient force of the springs. Consequently, contact of the free ends of the arms 44, 46 with the walls 60, 62 gradually reduces in terms of contact area; thereby reducing interfacial friction.

In Figure 6(b), interfacial friction is typically caused by the free ends of the arm 44, 46 coming in contact with and rubbing against the retaining bracket 36 at the walls 60, 62 of the aperture 37. However, in various embodiments, 5 interfacial friction may be provided by contact between the free ends of the arms and any surfaces with which the free ends come into contact at their respective second expanded positions.

The surfaces are for the primary purpose of providing 10 interfacial friction and may be any absorbent surfaces. Besides the walls of the aperture of the retaining bracket, these surfaces may be in the forms of posts or the like strategically located within the retaining bracket to facilitate contact with the free ends of the expanded arms. 15 These surfaces may also be provided by members located near the knob of the circuit breaker to facilitate contact with the free ends of the expanded arms; thereby providing interfacial friction. Such a surface may be generally referred to as a surface of a complementary device, wherein the complementary 20 device may be the retaining bracket or the circuit breaker.

The surface of the complementary device is located radially R_2 from the center of rotation. In use, the arms of the rotary adaptor experience a centrifugal force and may move toward their respective second expanded positions, reaching 25 the surface of the complementary device at R_2 . The protruding members of the rotary adaptor are designed in a way to provide R_1 to be larger than R_2 . When in use, the arms would reach the surface of the complementary device at R_2 first; therefore, the arms, being blocked at R_2 , would not be able to expand 30 further to R_1 . In other words, the protruding members at R_1 would remain as a precautionary feature only in case of mishandling of the rotary adaptor when it is not in use, as described hereinabove.

In use, when there is no further turning force applied to the switching device aiding the angular velocity or opposing the deceleration of the rotary adaptor 34, the rotary adaptor 34 eventually decelerates to provide rotation at a resultant
5 angular velocity of less than the threshold T. When this occurs, the arms 44, 46 do not come in contact with the walls 60, 62; thereby removing interfacial friction. Additionally, the moving contact of the circuit breaker tends to mildly hit and minimally bounce off the stationary mating contact at the
10 "CLOSE" position. In such a case, the moving contact makes eventual contact with the stationary mating contact, thus the switching device shows a true and well-positioned "CLOSE" indication and the circuit breaker 32 (not shown in Figure 6(b)) is closed.

15 Turning between the "CLOSE" position and the "TRIPPED" position usually involves the rotation of the rotary adaptor within or less than an angle of 90 degrees. Thus, the time required for the turning action (in fast motion) is relatively short. With the angular velocity of the rotary adaptor being
20 typically large, the acceleration of the moving contact of the circuit breaker is relatively high. The use of the rotary adaptor with decelerating mechanism activated translates to a reduced acceleration of the moving contact of the circuit breaker. Even if the angular velocity is maintained or
25 lowered, the rotary adaptor with decelerating mechanism advantageously provides sufficient delay at the "CLOSE" position to maintain the circuit knob axle at the "CLOSE" position.

30 Outward expansion of the free ends of the arms is dependent on centrifugal force. Centrifugal force depends on the weight/mass of an object, in this case, the arm(s), the speed of rotation, and the distance from the center of rotation. The more massive the arm(s), the greater the force; the greater the speed of the rotation, the greater the force;

and the greater the distance from the center of rotation, the greater the force.

5 The material and dimensions of the arm(s) determine the weight/mass of the arm(s) while the construction, shape or arrangement of the arm(s) relate to the distance from the center of rotation. By manipulating these parameters, various embodiments of the invention may be explored as seen in Figures 7 to 9.

10 Figure 7 shows a different embodiment of a rotary adaptor 70 comprising a body 71 and a protrusion 73. The body 71 of the rotary adaptor 70 may be made of monolithic plastic and may be formed by plastic molding or machining. The body 71 is attachable or shaped to be fit-attachable to the knob of the circuit breaker. The rotary adaptor 70 further comprises an
15 arm 75, which is pivotable between a first position wherein the arm 75 is retracted and a second position wherein the arm 75 is expanded outwardly. An end of the arm 75 is pivotably held to the rotary adaptor by a pin 77. A spring 79 is also arranged between the pivotable arm 75 and the rotary adaptor
20 70 to provide a resilient force on the arm 75 so that the arm 75 is retractable to a first retracted position. In this embodiment, the arm 75 is arc-shaped and contours along the circumference of the protrusion 73.

25 The arm may be coupled to anywhere along the body. Figure 7(b) shows a modified embodiment of Figure 7(a) wherein an arm 76 is coupled to a body 72 via a pin 78 at a location offset from a protrusion 74.

30 Figure 8(a) shows yet another embodiment of a rotary adaptor 80 comprising a pair of arms 81a, 81b, with each arm 81a, 81b having an end being pivotably held to the rotary adaptor 80 by respective pins 82a, 82b. Respective springs 83a, 83b are also arranged between the corresponding pivotable arms 81a, 81b and the rotary adaptor 80 to provide resilient force on the arms 81a, 81b so that the arms 81a, 81b are

retractable to their respective first retracted positions. In this embodiment, the arms 81a, 81b are substantially straight. The arms 81a, 81b are also comparatively shorter than those of the embodiments as shown in Figure 4 or 7. The lengths of the arms 81a, 81b are nonetheless sufficiently long so that when expanded to their respective second expanded positions, their free ends come into contact with the walls of the aperture or surfaces (not shown in Figure 8) to cause interfacial friction.

Figure 8(b) shows another embodiment of a rotary adaptor 84 similar to that as in Figure 8(a) comprising an arm 85 having an end being pivotably held to the rotary adaptor 84 by a pin 86. A spring 87 is also arranged between the pivotable arm 85 and the rotary adaptor 84 to provide a resilient force on the arm 85 so that the arm 85 is retractable to its respective first retracted position.

Figure 9 shows a different embodiment of a rotary adaptor 90 comprising a body 91 and a protrusion 92. The body 91 of rotary adaptor 90 may be made of monolithic plastic and may be formed by plastic molding or machining. The body 91 is attachable or shaped to be fit-attachable to the knob of the circuit breaker (not shown in Figure 9). In this embodiment, the rotary adaptor 90 further comprises arms 94, 96, which are extendable between a first position wherein the arms 94, 96 are retracted and a second position wherein the arms 94, 96 are expanded or extended outwardly. An end of each of the arms 94, 96 is connected to a ring 98, which is attachable or releasably attachable to the protrusion 92. The ring 98 may be made of a resilient or elastic material such as rubber. The ring 98 is held in place by fitting around the circumference of the protrusion 92.

The embodiment of Figure 9 operates based on the same principle of centrifugal force and experiences deceleration

primarily due to interfacial friction, as in the embodiments of Figures 4 to 8.

5 In the embodiment of Figure 9(a), when the rotary adaptor 90 rotates at an angular velocity of less than a threshold T , the centrifugal force is not large enough to overcome inertia and the weight of the arms 94, 96. Thus, the arms 94, 96 remain substantially at their first retracted positions and cannot extend or expand to their respective second expanded positions.

10 In the embodiment of Figure 9(b), when the rotary adaptor 90 rotates at an angular velocity of more than or equal to the threshold T , the centrifugal force is sufficiently large to overcome inertia and the weight of the arms 94, 96. Thus, the arms 94, 96 extend from their respective retracted position as
15 profiled by dotted lines 93, 97 to their respective second expanded positions. At the second expanded positions, the free ends of the arms 94, 96 come into contact with the walls of the aperture or surfaces (not shown in Figure 9); thereby causing interfacial friction, which in turn provides an
20 opposing force to the rotary motion of the rotary adaptor 90, and consequently leads to the deceleration of the rotary adaptor 90.

With the rotary adaptor 90 decelerating, the centrifugal force is weakened and the free ends of the arms 94, 96
25 experience an inward retracting force mainly due to the weight of the arms 94, 96. Resilient members, for example, springs (not shown in Figure 9) may be included to the arms 94, 96 to enhance the retraction of the arms 94, 96.

30 As seen in Figure 9(c), when rotary adaptor 90 is decelerating, the arms 94, 96 slowly retract toward their first retracted positions as a result of primarily the weakened centrifugal force and in the case where springs are included, the resilient force of the springs. Consequently, contact of the free ends of the arms 94, 96 with the walls or

surfaces (not shown in Figure 9) gradually reduces; thereby reducing interfacial friction.

The embodiment in Figure 9 comprises two arms 94, 96. However, the rotary adaptor 90 may accommodate any number of
5 arms and the number of arms is not limited to one or two. The arms may be made of resilient material, for example, rubber or plastics with elastic properties.

With the use of the embodiments of the present invention, the TAM remains sensitive to the "TRIP" function of the
10 circuit breaker. The TAM is coupled to the retaining bracket. The rotary adaptor with decelerating mechanism is assembled between the TAM and the circuit breaker's knob axle. When the user turns the TAM to the "CLOSE" position at any given speed, the arms on the rotary adaptor expand, according to the
15 angular velocity. When expanded, the arms contact the friction surfaces. The generated friction between the friction surfaces and the arms effectively decelerates the rotary motion of the rotary adaptor, and hence the knob axle. When the angular motion is sufficiently low, the arms retract due to the
20 resilient forces of the springs or the arms. Thus, the generated frictions are removed and the TAM becomes sensitive to the circuit breaker's operation.

It will be appreciated by a person skilled in the art that numerous variations and/or modifications may be made to
25 the present invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

CLAIMS

1. A rotary adaptor with decelerating mechanism for connection
5 to a complementary device comprising:
a body; and
at least one arm having one end configured to couple to the
body, the at least one arm movable between a first position and a
second position, wherein
10 in the first position, the at least one arm is retracted,
and
in the second position, the at least one arm is expanded
outwardly with the other end of the at least one arm configured
to contact a surface of the complementary device to provide
15 interfacial friction.
2. The rotary adaptor as claimed in claim 1, wherein in use,
when the rotary adaptor is rotating at an angular velocity of
more than or equal to a threshold, the at least one arm expands
20 outwardly to the second position, wherein
the other end of the at least one arm contacts and rubs
against the surface of the complementary device to provide
interfacial friction and cause decelerating of the rotary motion.
- 25 3. The rotary adaptor as claimed in claim 2, wherein in use,
when the rotary adaptor experiences decelerating rotation due to
interfacial friction, the at least one arm retracts from the
second position toward the first position; thereby allowing the
other end of the at least one arm to reduce contacting and
30 rubbing against the surface of the complementary device to reduce
interfacial friction.

4. The rotary adaptor as claimed in claim 3, wherein in use, when the rotary adaptor decelerates due to reduced interfacial friction and rotates at an angular velocity of less than the threshold, the at least one arm retracts toward the first
5 position to a point where interfacial friction is removed.

5. The rotary adaptor as claimed in claim 1, wherein in use, when the rotary adaptor rotates at an angular velocity of less than a threshold, the at least one arm is substantially in the
10 first position.

6. The rotary adaptor as claimed in any one of claims 2 to 5, wherein the threshold is obtainable by statistical studies, simulations or experimental tests.
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7. The rotary adaptor as claimed in any one of the preceding claims, wherein the complementary device comprises a circuit breaker.

20 8. The rotary adaptor as claimed in any one of claims 1 to 6, wherein the complementary device comprises a retaining bracket having an aperture.

9. The rotary adaptor as claimed in claim 8, wherein the
25 surface of the complementary device comprises a wall of the aperture.

10. The rotary adaptor as claimed in any one of the preceding claims, wherein the one end of the at least one arm is pivotably
30 coupled to the body by a pin, the pin being receivable in a recess provided by the rotary pin.

11. The rotary adaptor as claimed in any one of the preceding claims, wherein the at least one arm is held in the first position by a spring.
- 5 12. The rotary adaptor as claimed in claim 11, wherein the spring is arranged between the one end of the at least one arm and the body.
- 10 13. The rotary adaptor as claimed in claim 12, wherein the body further comprises a protruding member located at a pre-determined point for blocking the at least one arm from move outwardly beyond the pre-determined point; thereby preventing the spring from deforming or from being displaced from its original arrangement.
- 15 14. The rotary adaptor as claimed in any one of claims 11 to 13, wherein the at least one arm is made of metal.
- 20 15. The rotary adaptor as claimed in claim 14, wherein the at least one arm is formed by metallic sintering or die casting.
- 25 16. The rotary adaptor as claimed in any one of claims 1 to 9, further comprising a protrusion positioned along the body, wherein
the one end of the at least one arm is coupled to the body by a ring, the ring being attachable to the protrusion.
- 30 17. The rotary adaptor as claimed in claim 16, wherein the ring is made of a resilient or elastic material.
18. The rotary adaptor as claimed in claim 16 or 17, wherein the at least one arm is made of a resilient material.

19. The rotary adaptor as claimed in any one of claims 16 to 18, wherein the at least one arm is held in the first position by a spring.

5 20. The rotary adaptor as claimed in any one of the preceding claims, wherein the at least one arm comprises two or more arms.

21. The rotary adaptor as claimed in claim 20, wherein each arm is arranged at substantially equidistance from an adjacent arm.

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22. The rotary adaptor as claimed in any one of the preceding claims, wherein the body of the rotary adaptor is made of monolithic plastic.

15 23. The rotary adaptor as claimed in any one of the preceding claims, wherein the body of the rotary adaptor is formed by plastic molding or machining.

24. An assembly comprising:

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a circuit breaker comprising a knob;

a tripping assistance mechanism (TAM) arranged to couple to the circuit breaker at its knob axle via a rotary adaptor with decelerating mechanism as claimed in any one of claims 1 to 23;

a retaining bracket encasing the rotary adaptor; and

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a switching device comprising a transmission shaft coupled to the TAM.