

INTERLOCK DEVICE FOR ENCLOSED SWITCHBOARD

5 The present invention relates generally to an
interlock device used for an enclosed switchboard and more
specifically to an interlock device which can lock an
operation handle so that a switching device disposed within
an enclosed switchboard is not allowed to be closed when
10 the switchboard door is left opened and unlock the
operation handle so that the switching device is allowed to
be closed only when the switchboard door is kept closed; in
other words, which can allow the door to be opened only
when the switching device is kept opened or allow the
15 switching device to be closed only when the door is kept
closed.

 In an enclosed switchboard, various switches,
meters, protection devices, etc. are arranged on a
switchboard front panel; a circuit breaker, a disconnecting
20 switch, bus bars, an earthing device, etc. are arranged
within a switchboard casing in order to protect these
electrical devices from dust and moisture and additionally
to enhance safety.

 In such an enclosed switchboard described above,
25 in the case where some trouble occurs in the circuit
breaker, for instance, or it is necessary to take out the
circuit breaker from the switchboard for maintenance, first

the switchboard panel is opened; secondly an operation handle is moved upward or downward to open a disconnecting switch for cutting off a high-voltage power supply from the circuit breaker; thirdly an inner door-like partition is moved frontward; lastly the circuit breaker is pulled out from the enclosed switchboard. In contrast with this, in the case where the circuit breaker is installed within the enclosed switchboard again, first the circuit breaker is pushed in within the switchboard; secondly the inner door-like partition is moved backward, thirdly the operation handle is moved downward or upward to close the disconnecting switch for applying a high-voltage power supply again to the circuit breaker; lastly the switchboard panel is closed.

15 In the process of opening or closing the door-like partition of the enclosed switchboard, in case the door-like partition is opened when the disconnecting switch is left closed, that is, a high-voltage power supply is left applied to the circuit breaker, this condition is very dangerous and may result in such an accident that the operator is killed by an electric shock. Therefore, there is generally provided a safety device called an interlock device within the enclosed switchboard. This interlock device allows the door-like partition to be opened only after the disconnecting switch has been kept opened to cut off a high-voltage power supply from the electrical device, so that the operator can enter the enclosed switchboard

safely. Further, the disconnecting switch can be closed for application of a high-voltage power supply to the circuit breaker only after the inner door-like partition has been closed perfectly. Furthermore, the door-like
5 partition is locked whenever the disconnecting switch is kept closed.

In the above-mentioned interlock device, conventionally, electrical interlock devices or electromechanical interlock devices are well known.

10 As the former example, it is possible to cite an interlock device as follows: In the case where a high-voltage is applied to a circuit breaker arranged within the enclosed switchboard, electric charge developed near the circuit breaker is detected by an appropriate sensor; a
15 relay is energized in response to a signal from the electric-charge sensor to activate an electromagnet; the enclosed switchboard door is locked by the electromagnet.

As the latter example, it is possible to cite an interlock device as follows: In the case where a high-
20 voltage is applied to a circuit breaker arranged within the enclosed switchboard, electric charge developed near the circuit breaker is detected; a warning lamp is lit up and a relay is energized to actuate a mechanical device; the enclosed switchboard door is locked by the mechanical
25 device.

The above-mentioned electrical or electromechanical interlock devices have some drawbacks or

shortcomings. The basic problems are:

(1) Another power supply is required to activate or actuate the electrical interlock device.

(2) Complicated steps are required when assembling the device using electrical elements and mechanical elements.

(3) It is relatively difficult to distinguish trouble due to mechanical elements from that due to electrical elements or vice versa.

(4) Probability of occurrence of trouble due to electrical elements is relatively high as compared with that due to mechanical elements.

For the reasons described above, it is rather preferable to construct the interlock device for an enclosed switchboard by the use of only mechanical elements.

Further, as described above, an interlock device is usually incorporated within the enclosed switchboard in order to prevent such an accident that the operation handle is erroneously operated to close the disconnecting switch when the switchboard door is open and therefore the operator is killed by an electric shock. However, in case the operation handle is operated erroneously by an excessive force in the direction to close the disconnecting switch in spite of the fact that the interlock device is functioning, there further exists such a danger that the interlock device may be damaged and therefore the operation

handle can easily be moved to a position at which the disconnecting switch is closed unintentionally when the switchboard door is left open.

5 For the reason described above, it is rather preferable to disable the operation handle for the interlock device for an enclosed switchboard before the interlock device is damaged due to erroneous operation such that an excessive force is carelessly applied to the operation handle.

10 With these problems in mind, therefore, it is the primary object of the present invention to provide an interlock device for an enclosed switchboard which is made up of only mechanical elements without use of any electrical elements such as relays, electromagnets, etc.

15 To achieve the above-mentioned object, the interlock device for an enclosed switchboard according to the present invention comprises an operation handle, a pivotable disk having a latch lock member, a link rod connected between the pivotable disk and a switching
20 device, a triangular disk latch having a disk latch pawl and a disk latch slot, a disk latch actuator having an actuator rod, an actuator pin, and a spring, a partition latch having a partition latch pawl and a partition latch pin, a partition latch lever having an elongate latch lever
25 slot, etc.

The disk latch locks or unlocks the pivotable disk in relation to the opening or closing of the door-like

partition and the partition latch locks or unlocks the door-like partition in relation to the angular motion of the pivotable disk or the closing or opening of the disconnecting switch.

5 Since the interlock device according to the present invention is made up of only mechanical elements without use of any other electrical elements, it is easy to troubleshoot defective elements and to repair the device, while improving the life time.

10 The other object of the present invention is to provide an operation handle which is disabled easily into damage or bend intentionally whenever an excessive force is applied to the operation handle, before the interlock device is damaged or further the disconnecting switch is
15 closed dangerously due to erroneous operation while the switchboard door is left opened.

 To achieve the above-mentioned object, the operation handle according to the present invention comprises a handle rod including a mechanically fragile
20 portion at an appropriate position of the handle rod. The fragile portion is a neck or a notch formed in the handle rod or a joint member sandwiched between two tubular handle rods.

 The features and advantages of the interlock
25 device for an enclosed switchboard according to the present invention will be more clearly appreciated from the following description of the preferred embodiments of the

invention taken in conjunction with the accompanying drawings in which like reference numerals designate the same or similar elements or sections throughout the figures thereof and in which;

5 Fig. 1 is a pictorial view of an exemplary enclosed switchboard for assistance in explaining the function of the interlock device according to the present invention;

10 Fig. 2 is an enlarged diagrammatical side view of the interlock device according to the present invention, in which the door-like partition is closed but the operation handle is not yet moved downward to close a disconnecting switch, both the latches being disengaged from both the latch lock members, respectively;

15 Fig. 3 is an enlarged diagrammatical side view of the interlock device according to the present invention for assistance in explaining the operation thereof, in which a door-like partition is closed, and an operation handle is moved downward to close a disconnecting switch, so that the
20 door-like partition is locked by a partition latch;

 Fig. 4 is an enlarged diagrammatical side view of the interlock device according to the present invention for assistance in explaining the operation thereof, in which the operation handle is moved upward to open the
25 disconnecting switch and the door-like partition is opened, so that the operation handle is locked by a disk latch;

 Fig. 5 is a side view of a first embodiment of

the operation handle used for the interlock device according to the present invention;

Fig. 6 is a cross-sectional view taken along the line VI-VI shown in Fig. 5;

5 Fig. 7 is a side view of a second embodiment of the operation handle used for the interlock device according to the present invention;

Fig. 8 is a cross-sectional view taken along the line VIII-VIII shown in Fig. 7; and

10 Fig. 9 is an enlarged fragmentary cross-sectional view of a third embodiment of the operation handle used for the interlock device according to the present invention.

15 To facilitate understanding of the present invention, a brief reference will be made of the structure of an exemplary enclosed switchboard within which the interlock device according to the present invention is installed, with reference to the attached drawing.

In Fig. 1, an enclosed switchboard 1 is made up
20 of a casing 2, a door panel 3 and a door-like partition 4. Within the enclosed switchboard 1, there are mainly arranged a circuit breaker 5, a disconnecting switch 6 and an interlock device 7. Further, the reference numeral 8 denotes an operation handle linked with a link rod 9 via
25 the interlock device 7 to close or open the disconnecting switch 6; the reference numeral 10 denotes three bus-supporting insulators; the reference numeral 11 denotes

power supply bus bars connected to the disconnecting switch 6 via a branched bus; the reference numeral 12 denotes a bus supporting insulator; the reference numeral 13 denotes a load cable connected to the circuit breaker 5 via a load bus 13a; the reference numeral 14 denotes a cable supporting member.

In the enclosed switchboard 1, when access to the circuit breaker 5, for instance, is required for checking or maintenance, first it is necessary to open the disconnecting switch 6 by operating the operation handle 8 for cutting-off a high-voltage power supply from the circuit breaker 5. Fig. 1 shows a state where the operation handle 8 is moved upward and the link rod 9 is shifted toward the left to open the disconnecting switch 6 in such a way that a movable blade 6a is kept apart from a fixed blade 6b.

In this case, if the door-like partition 4 is first opened carelessly when the disconnecting switch 6 is closed, that is, when a high-voltage power supply is left applied to the circuit breaker 5, this condition is seriously dangerous because the operator may be killed by an electric shock. To prevent such dangerous condition, there is usually provided an interlock device 7 within the enclosed switchboard 1. This interlock device 7 serves as a safety device as follows: the door-like partition 4 can be opened only after the operation handle 8 has been moved upward to open the disconnecting switch 6; the operation

handle 8 can be moved downward to close the disconnecting switch 6 only after the door-like partition 4 has been closed perfectly; the door-like partition 4 can be locked perfectly in the closed condition except the case where the operation handle 8 has been moved upward to open the disconnecting switch 6.

The interlock device 7 according to the present invention will be described hereinbelow in more detail with reference to Figs. 2, 3 and 4.

The interlock device 7 can be divided mainly into four sections: a pivotable disk section supported by a disk supporting member 20, a disk latch section supported by a disk latch supporting member 21, a partition latch section supported by a partition latch supporting member 22, and a partition latch lever 23.

The disk supporting member 20 is fixed in position within the enclosed switchboard 1, on which a pivotable disk 24 is pivotably supported through a shaft 25. To the pivotable disk 24, a handle supporting member 26 is fixed. The operation handle 8 is fixed to the handle supporting member 26 in an appropriate method (explained later in more detail with reference to Figs. 5 to 9). Therefore, when the operation handle 8 is moved up and down with the shaft 25 as its pivot, the pivotable disk 24 is rotated clockwise or counterclockwise. Further, a link rod 9 is pivotably connected to the pivotable disk 24 via a pin 24a so that when the pivotable disk 24 is pivoted clockwise

(the operation handle is moved upward), the link rod 9 is shifted toward the left in the figure to open a disconnecting switch 6, for instance, and when the pivotable disk 24 is pivoted counterclockwise (the operation handle is moved downward), the link rod 9 is shifted toward the right in the figure to close the disconnecting switch 6. Additionally, the partition latch lever 23 is also pivotably connected to the pivotable disk 24 via a pin 24b, an angular distance away from the position where the link rod 9 is pivoted, so that when the pivotable disk 24 is pivoted clockwise (the operation handle is moved upward), the partition latch lever 23 is moved downward and when the pivotable disk 24 is pivoted counterclockwise (the operation handle is moved downward), the latch lever 23 is moved upward. Furthermore, a latch lock member 28 is fixed to the pivotable disk 24 an angular distance further away from the position where the latch lever 23 is pivoted.

The disk latch supporting member 21 is fixed in position near the circumferential portion of the pivotable disk 24 within the enclosed switchboard 1, on which a disk latch actuator 29 is fixed and a triangular disk latch 30 is pivotably supported through a shaft 31. The disk latch actuator 29 includes a pair of actuator rod guide plates 29a standing upright from the surface of the disk latch supporting member 21, an actuator rod 29b slidably passed through the central holes formed in a pair of the actuator

rod guide plates 29a, and a coil spring 29c disposed between the flange portion 29b' near the end portion of the actuator rod 29b and one of the actuator rod guide plates 29a so as to urge the actuator rod 29b toward the door-like partition 4. Further, when the door-like partition 4 is opened toward the left in Fig. 2, the actuator rod 29b is urged toward the left by the elastic force of the coil spring 29c; however, when the door-like partition 4 is closed toward the right, the actuator rod 29b is pushed toward the right against the elastic force of the coil spring 29c by the flat surface of a partition latch lock plate 4a formed integrally with the door-like partition 4. Furthermore, an actuator pin 29d is implanted perpendicular to the surface of the disk latch supporting member 21 at an appropriate position on the actuator rod 29b.

The triangular disk latch 30 is pivotably supported by the shaft 31 on the disk latch supporting member 21 at one apex thereof, having a disk latch pawl 30a formed at another apex thereof in such a way as to be engageable with the latch lock member 28, and a disk latch slot 30b formed at the other apex thereof so as to be engageable with the actuator pin 29d implanted in the actuator rod 29b.

The partition latch supporting member 22 is fixed in position near the disk latch supporting member 21, on which a partition latch 32 is pivotably supported through a shaft 33. The partition latch 32 is formed with a

partition latch pawl 32a in such a way as to engageable
with the partition latch lock plate 4a of the door-like
partition 4. Further, a partition latch pin 32b is fixed
to the door-like partition latch 32 on the side opposite to
5 the partition latch pawl 32a in such a way as to engageable
with an elongate latch lever slot 23a formed at the end
portion of the partition latch lever 23. Further, the
partition latch lever 23 is positioned over the disk latch
actuator 29 and the triangular disk latch 30 without
10 contacting with these elements when moved.

Furthermore, the length of the elongate latch
lever slot 23a must be sufficient to disengage the
partition latch pawl 32a from the partition latch lock
plate 4a of the partition 4 and to engage therewith when
15 the pivotable disk 24 is rotated clockwise or
counterclockwise, for instance, through an angle of 90
degree and therefore the partition latch lever 23 is moved
to its extreme ends.

The operation of the interlock device according
20 to the present invention will be explained hereinbelow with
reference to Figs. 3 and 4. Fig. 3 shows the state where
the door-like partition 4 is closed and simultaneously kept
locked and the operation handle 8 is moved downward to
close the disconnecting switch.

25 The partition 4 will not be opened immediately in
this state shown in Fig. 3, because the partition latch
pawl 32a of the partition latch 32 is engaged with the

latch lock plate 4a of the partition 4. Therefore, the operator must first moves the operation handle 8 upward. When the handle 8 moves upward, the pivotable disk 24 rotates clockwise, so that the link rod 9 is shifted to open the disconnecting switch (not shown) and simultaneously the partition latch lever 23 is moved downward. When the partition latch lever 23 moves downward, the upper end of the elongate latch lever slot 23a is brought into contact with the partition latch pin 32b and further moves the partition latch pin 32b downward, so that the partition latch 32 pivotes clockwise with the shaft 33 as its pivot. As a result, the partition latch pawl 32a of the partition latch 32 is disengaged from the partition latch lock plate 4a, as shown in Fig. 4. Therefore, the door-like partition 4 can be opened. When the partition 4 is once opened, since the actuator rod 29b is released and therefore urged toward the left by the elastic force of the coil spring 29c. As a result, the actuator rod pin 29d engages with the disk latch slot 30b to pivot the triangular disk latch 30 counterclockwise with the shaft 31 as its pivot and to engage the disk latch pawl 30a with the latch lock member 28, also as shown in Fig. 4. As a result, once the door-like partition 4 is opened, the operation handle 8 will not be moved downward to rotate the pivotable disk 24, in order words, to close the disconnecting switch. Further, in this state, although the pivotable disk 24 is not locked in the clockwise direction,

the operation handle 8 will not be moved further upward, because of the presence of the end of a front plate 27.

In the case where the door-like partition 4 is required to close in this state shown in Fig. 4, the operation handle 8 will not be moved in either direction, because the pivotable disk 24 is locked. Therefore, the operator must first closes the door-like partition 4. When the door-like partition 4 is once closed, since the actuator rod 29b is pushed toward the right against the elastic force of the coil spring 29c, the actuator rod pin 29d received within the disk latch slot 30b pivotes the triangular disk latch 30 clockwise to disengage the disk latch pawl 30a from the latch lock member 28, as shown in Fig. 3. Therefore, since the operation handle 8 or the pivotable disk 24 is released from the lock and is pivotable, the operator can move the operation handle 8 downward. When the handle 8 moves downward, the pivotable disk 24 pivotes counterclockwise, so that the link rod 9 is shifted toward the right to close the disconnecting switch 6 and simultaneously the partition latch lever 23 is moved upward. When the partition latch lever 23 moves upward, the lower end of the elongate latch lever slot 23a is brought into contact with the partition latch pin 32b and further moves the partition latch pin 32b upward, so that the partition latch 32 pivotes counterclockwise. As a result, the partition latch pawl 32a of the partition latch 32 is engaged with the partition latch lock plate 4a, as

shown in Fig. 3. As a result, once the operation handle 8 is moved downward to close the disconnecting switch 6, the door-like partition 4 is locked and therefore will not be opened.

5 Description has been made of the case where a disconnecting switch is opened or closed in relation to the opening or closing of the door-like partition of the enclosed switchboard on the basis of the embodiment. However, without limiting to the disconnecting switch, the
10 interlock device according to the present invention is applicable to any other switching devices arranged within the enclosed switchboard, for instance, such as an earthing switch.

Figs. 5 to 9 show the operation handle used for
15 the interlock device according to the present invention.

The operation handle according to the present invention comprises at least one mechanically weak or fragile portion intentionally so as to be easily broken or bent. This operation handle is provided in order to
20 prevent an danger such that the operation handle is forcibly moved carelessly in the direction to close the disconnecting switch in spite of the fact that the interlock device is functioning. In other words, this fragile portion of the handle serves as an additional
25 safety device to previously prevent an accident due to erroneous operation.

Figs. 5 and 6 show a first embodiment of the

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operation handle according to the present invention. In the figure, the operation handle 8 comprises a tubular portion 8a with a mechanically weak neck portion 8b which is formed by roller compression, a handle knob 8c and a thread portion 8d. The position and the diameter (or wall thickness) of the small-diameter neck portion 8b are important in order to determine the strength of the operation handle 8. If the neck portion 8b is formed immoderately near the thread portion 8d, the operation handle 8 may be not strong enough to pivot the pivotable disk 24 and to close or open the disconnecting switch, although the strength depends upon the diameter, wall thickness and material. On the other hand, if the neck portion 8b is formed excessively near the handle knob 8c, the operation handle 8 may not serves as a safety device. That is to say, the bending strength should be sufficient to drive the disconnecting switch but insufficient to resist against an excessive force.

Further, in order to facilitate the replacement of the damaged operation handle for a new one, the handle 8 should be attached removably to the interlock device. For this purpose, the thread portion 8d is provided for the operation handle 8. Therefore, when replacing the operation handle, the handle 8 is readily screwed into or out of the inner thread portion formed in the handle supporting member 26 shown in Fig. 2. The neck portion 8b can be manufactured by partially drawing down a tubular

material into a predetermined small diameter. In this work, a pair of rollers are brought into pressure-contact with a rotating tubular material. Fig. 6 is a cross-sectional view taken along the lines VI-VI shown in Fig. 5.

5 Figs. 7 and 8 show a second embodiment of the operation handle according to the present invention. In the figure, the operation handle 8 comprises a rod portion 8a with a mechanically weak notch 8b' which is formed by cutting, a handle knob 8c and a flat portion 8e with a
10 plurality of bolt holes. The position and the shape of the notch 8b' are important in order to determine the strength of the operation handle 8. The notch portion 8b' can be manufactured by cutting the rod portion with a lathe. In this embodiment, the operation handle 8 is fixed to the
15 handle supporting member 26 by the use of a plurality of bolts. Fig. 8 is a cross-sectional view taken along the line VIII-VIII shown in Fig. 7.

Fig. 9 shows a third embodiment of the operation handle according to the present invention. In this
20 embodiment, the tubular portion 8a is first divided into two sections and then the divided two tubular portions 8a are joined to each other with a joint member 8f made of wood, synthetic resin or light metal so as to form a mechanically fragile portion.

25 In any embodiments described above, the shape of the cross-section of the handle is not important, but the bending strength must be strong enough to pivot the

pivotal disk, that is, to close or open the disconnecting switch and weak enough to be broken or bent easily when an excessive bending moment is applied to the operation handle.

5 As described above, in the interlock device for an enclosed switchboard according to the present invention, the door-like partition can be opened only when the disconnecting switch is opened and locked automatically whenever the disconnecting switch is closed and further the
10 disconnecting switch can be closed only after the door-like partition has been closed perfectly; in other words, the operation handle is locked automatically when the door-like partition is left open and is unlocked when the door is kept closed.

15 Further, since the interlock device according to the present invention is made up of only mechanical parts or elements without use of any electrical elements, there existing no trouble with electrical elements, it is easy to troubleshoot defective elements and easy to repair, thus
20 enhancing the safety and the life time.

 Furthermore, since the operation handle according to the present invention is formed with a mechanically weak or fragile portion, even when an excessive bending moment is applied to the handle
25 erroneously or carelessly, it is possible to prevent the interlock device from being damaged or to prevent such a danger that the operation handle is forcibly moved

carelessly in the direction to close the disconnecting switch, thus enhancing the safety doubly.

It will be understood by those skilled in the art that the foregoing description is in terms of preferred
5 embodiments of the present invention wherein various changes and modifications may be made without departing from the spirit and scope of the invention, as set forth in the appended claims.

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CLAIMS

1. An interlock device for an enclosed switchboard for allowing a switching device to be closed or opened in relation to the closing or opening of a door-like partition provided for the enclosed switchboard, which comprises:

(a) an operation handle;

(b) a pivotable disk having a latch lock member, said operation handle being removably fixed thereto for pivoting said pivotable disk to positions to close or open the switching device;

(c) a link rod, one end of which is pivotably connected in position to said pivotable disk and the other end of which is pivotably connected to the switching device in such a way that the switching device can be closed when said pivotable disk is pivoted in one direction and opened when said pivotable disk is rotated in the other direction;

(d) a disk latch having a disk latch pawl and a disk latch slot;

(e) a disk latch actuator having an actuator rod, an actuator pin, and a spring, said actuator rod being urged toward the door-like partition by the elastic force of said spring, said actuator pin being received within said disk latch slot of said disk latch in such a way that said disk latch pawl of said disk latch is engaged with said latch lock member of said pivotable disk when said door-like partition is opened but disengaged from said



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latch lock member when said door-like partition is closed;

(f) a partition latch having a partition latch pawl and a partition latch pin;

(g) a partition latch lever having an elongate latch lever slot at one end thereof, the other end thereof being pivotably connected in position to said pivotable disk, said partition latch pin being received within said elongate latch lever slot in such a way that said partition latch pawl of said partition latch is engaged with a partition latch lock plate provided for the partition when said pivotable disk is pivoted in the direction to close the switching device but disengaged from said partition latch lock plate when said pivotable disk is pivoted in the direction to open the switching device;

whereby the door-like partition can be opened only after said pivotable disk has been pivoted in the direction to open the switching device and locked in the closed condition except the case described above and further said pivotable disk can be pivoted in the direction to close the switching device only after the door-like partition has been closed perfectly.

2. An interlock device for an enclosed switchboard as set forth in claim 1, wherein said operation handle comprises a handle rod formed with a mechanically fragile portion at an appropriate position thereof.



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3. An interlock device for an enclosed switchboard as set forth in claim 2, wherein said fragile portion is a joint member for connecting two separate tubular handle rods on either side thereof.

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4. An interlock device for an enclosed switchboard as set forth in claim 3, wherein said joint member is made of a synthetic resin.

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5. An interlock device for an enclosed switchboard as set forth in claim 3, wherein said joint member is made of a wood.

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6. An interlock device for an enclosed switchboard as set forth in claim 3, wherein said joint member is made of a light metal.

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7. An interlock device as claimed in claim 1 and substantially as herein described with reference to the accompanying drawings.
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