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METAL ENCLOSED SWITCHGEAR

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The present invention relates to a metal enclosed switchgear comprising a circuit breaker of the pullout type (hereinafter referred to as a circuit breaker), an earthing switch which earths a load circuit when necessary, and an interlock between the circuit breaker and the earthing switch.

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Generally, a metal enclosed switchgear comprises an earthing switch and a mechanical interlock between the earthing switch and the circuit breaker. The earthing switch serves to earth such electrical devices as belong to a load circuit connected to the circuit breaker prior to maintenance and/or inspection of the electrical devices of the load circuit.

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The mechanical interlock must meet the following requirements:

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1) When the earthing switch is closed, the circuit breaker can not be moved to its electrically connected position from its electrically disconnected position, or its position outside of its cabinet, and conversely when the earthing switch is opened, the circuit breaker is allowed to be moved to its electrically connected position from its electrically disconnected

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position, or its position outside of the cabinet;

2) When the circuit breaker is in its electrically connected position, the earthing switch can be opened or closed, and conversely, when the circuit breaker is in its electrically disconnected position or out of the cabinet, the earthing switch can be opened or closed.

Mechanical interlocks in accordance with requirement 1) such as shown in Fig. 1 are known. For better understanding of the present invention, the basic arrangement of a conventional metal enclosed switchgear employing the mechanical interlock A will be described first in conjunction with Fig. 1. The switchgear includes a floored cabinet 2, the interior of which is divided into a front chamber 3 accommodating a circuit breaker, an upper rear chamber 4 accommodating a power supply bus, and a lower rear chamber 5 accommodating a load bus. A vertical partition 6 is provided between the circuit breaker chamber 3 and the power supply bus chamber 4 and load bus chamber 5. A horizontal partition 7 is provided between the power supply and load bus chambers 4 and 5.

A circuit breaker 8 is installed in an electrically connected position within the circuit breaker chamber 3. The circuit breaker 8 can be drawn out of the cabinet 2 (i.e., to the left in Fig. 1). The circuit breaker 8 is provided with a plurality of rollers 9 rolling along the floor 2a of the cabinet 2.

A pair of disconnectors 12 and 13 are fixed to and extend through the vertical partition 6 behind the circuit breaker 8. One disconnector 12 extends into both the circuit breaker and power supply bus chambers 3 and 4. The other disconnector 13 extends into both the circuit breaker and load bus chambers 3 and 5. A terminal (not shown) of the power supply bus 14 is housed within the first disconnector 12. On the other hand, a terminal (not shown) of the load bus 15 is housed within the other disconnector 13.

Connecting rods 16 and 17, each having an electrical plug (not shown) which is removable from the terminal of the power supply bus 14 or load bus 15, extend toward the disconnectors 12 and 13 respectively. The electrical plugs are connected to a pair of electrodes (not shown) of the circuit breaker 8, respectively.

An earthing switch 18 is mounted on a part of the vertical partition 6 facing the load bus chamber 5. The earthing switch 18 has a stationary blade 19 extending downward from its rear end and a movable blade 20 at its front end. The movable blade 20 can be thrown into or out of contact with the stationary blade 19. The stationary blade 19 is connected to the load bus 15 via a connecting bus 10. The movable blade 20 is rigidly secured to the pivot point of an operating end lever 21. The distal end of the operating end lever 21 is pivotably attached to the rear end of the earthing switch operating rod 23, which

extends to the front of the cabinet 2, by means of a stationary pivot 22 which is stationary relative to the earthing switch 18. As apparent from Fig. 2, the earthing switch operating rod 23 is arranged to one side of the circuit breaker 8.

The movable blade 20 extends downward in an opened position of the earthing switch 18 and is rotated through about 90° counterclockwise in Fig. 1 when the earthing switch 18 shifts from its opened position to its closed position. The earthing switch operating rod 23 can shift axially. The front end thereof is attached to one end of a bell crank 24 by means of a movable pivot 25. The apex of the bell crank 24 is supported by a stationary pivot 26 which is in turn supported by an operating box 27 attached to the cabinet 2. The bell crank 24 is rotated by an operator by means of a handle 24a. The bell crank 24 is in the position shown in dashed lines in Fig. 1 when the earthing switch 18 is open. On the other hand, the bell crank 24 is in the position shown in dot-dashed lines in Fig. 1 when the earthing switch 18 is closed.

In this metal enclosed switchgear structure, an interlock A comprises a blocking stopper 28 which is fixed to a predetermined point on the earthing switch operating rod 23. The stopper 28 can come into contact with the rear of the circuit breaker 8, thus blocking further rearward movement of the circuit breaker 8. As shown in Fig. 1, the earthing switch operating rod 23 is in the solid-lined

position and the stopper 28 is slightly behind the circuit breaker 8 which is in the solid-lined electrically connected position in Fig. 1, when the earthing switch 18 is open. After the circuit breaker 8 is moved from the electrically connected position to the phantom-lined electrically disconnected position in Fig. 1 or out of the cabinet 2, the earthing switch 18 can be closed by moving the handle 24a upward for the purpose of maintaining and/or inspecting the electrical elements of the load circuit, the stopper 28 being moved forward within the cabinet 2 (i.e., to the left in Fig. 1) together with the earthing switch operating rod 23. Thus, the circuit breaker 8, once moved to the electrically disconnected position or out of the cabinet 2, is prevented from moving into the electrically connected position by the stopper 28.

However, in accordance with the above interlock A, the load due to the impact of the circuit breaker 8 against the stopper 28 is applied directly to the earthing switch operating rod 23, and the operating end lever 21 and bell crank 24 which constitute a link mechanism together with the earthing switch operating rod 23. Therefore, the operating box 27 and the earthing switch 18 must be stoutly fixed to the respective cabinet 2 and vertical partition 6. On the other hand, even if they are stoutly fixed, the points of installation in the cabinet 2 and vertical partition 6 may be damaged.

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A primary object of the present invention is to provide a metal enclosed switchgear (metal-clad switchgear) including a mechanical interlock which can meet interlocking requirements namely that it prevent a
5 circuit breaker from being moved from its electrically disconnected position or from outside of a cabinet of the switchgear to its electrically connected position when the earthing switch is closed, and that it resists damage due to the translational inertia of the circuit
10 breaker as it moves into the cabinet.

Another object of the present invention is to provide a metal enclosed switchgear including a mechanical interlock between the circuit breaker and the earthing switch which can offset the load due to the impact
15 of the circuit breaker against a roller stopper.

Still another object of the present invention is to provide a metal enclosed switchgear including a mechanical interlock between the circuit breaker and an earthing switch which can stop the circuit breaker
20 accurately at a desired position.

The present invention provides metal-clad switchgear including:

a floored cabinet which has a vertical partition defining a circuit breaker chamber;

25 a pair of disconnectors fixed to the vertical partition;

a load bus;

an earthing switch for earthing a load circuit
connected to the load bus;

an earthing switch actuating mechanism including

5 an earthing switch operating rod having one end connected
to the earthing switch;

a circuit breaker including a pair of connecting
rods and a plurality of rollers arranged to roll along
the floor of the cabinet so as to enable the circuit

10 breaker to be moved into and out of the circuit breaker
chamber to electrically connect and disconnect each
connecting rod with an associated one of the disconnectors;

a mechanical interlock between the circuit breaker
15 and the earthing switch for preventing the circuit
breaker from attaining its electrically connected position
when the earthing switch is closed, wherein the
mechanical interlock comprises:

a pair of elongate stationary roller stoppers fixed
20 in spaced substantially parallel relationship with each
other to the floor of the cabinet, the stationary roller
stoppers lying outside the path of the rollers;

an elongate movable roller stopper, having substantially
the same width as the spacing between the
25 stationary roller stoppers, disposed in the spacing,

the movable roller stopper being arranged to be extended into and drawn back out of the path while being supported by the stationary roller stoppers; and

a link mechanism interlocking the earthing switch actuating mechanism and the movable roller stopper, the link mechanism being arranged to extend the movable roller stopper into the path when the earthing switch is closed to cause the movable roller stopper to block the path of at least one of the rollers.

According to this arrangement of the switchgear, the load applied to the movable roller stopper by the roller due to the impact of the roller against the movable roller stopper will be offset by a reactive force applied to the movable roller stopper by the stationary roller stoppers. Thus, the mechanical interlock will not be damaged by the above-mentioned impact. Additionally, the circuit breaker can be stopped accurately at the desired position, because the movable roller stopper, supported by the pair of stationary roller stoppers, effectively blocks

the path of the roller. Metal-clad switchgear constructed in accordance with the invention will now be described by way of example only with reference to the accompanying drawings, in which: Fig. 1 is predominantly an elevation of the interior of a conventional metal enclosed switchgear;

Fig. 2 is a plan view of the interlock of Fig. 1;

Fig. 3 is a side view of a mechanical interlock between the circuit breaker and the earthing switch according to the present invention;

Fig. 4 is an enlarged plan view of a roller stopping mechanism of the interlock of Fig. 3 showing a movable roller stopper in its inoperative position;

Fig. 5 is an enlarged plan view of the same roller stopping mechanism showing the movable roller stopper in its operative position; and

Fig. 6 is an enlarged elevation in partial section of the same roller stopping mechanism.

Referring to Figs. 3 to 5, a preferred embodiment of the present invention will be described hereinafter. In this description, the reference numerals used in Fig. 1 will be used to label elements of the metal enclosed switchgear 1 appearing in Fig. 1 and the description of such elements will not be repeated. A substantially triangular dual lever 29 which includes a pair of operating apices 30 and 32 is pivotally supported on a stationary pivot 26 mounted in an operating box 27. A movable pivot 31 is provided at the first operating apex 30. The dual

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lever 29 is connected to the front end of the earthing switch operating rod 23 by means of the movable pivot 31. A movable pivot 33 is provided at the second operating apex 32. The dual lever 29 is also connected to the upper
5 end of an operating source rod 34 for a movable roller stopper by means of the movable pivot 33. In addition, the dual lever 29 has an operating handle 35 at the remaining apex.

The lower end of the movable roller stopper
10 operating source rod 34, which reaches nearly to the floor 2a, is connected to one apex of a second triangular lever 37 by means of a movable pivot 36. Another apex of the second triangular lever 37 is hinged to the cabinet 2 by a stationary pivot 38. The remaining apex of the second
15 triangular lever 37 is connected by means of a movable pivot 39 to the front end of a connecting rod 40 which extends longitudinally within the cabinet 2 below the underside of the circuit breaker 8. The rear end of the connecting rod 40 has a movable pivot 40a.

20 As apparent from Fig. 3, a roller stopping mechanism D is provided at a predetermined place on the floor 2a within the circuit breaker chamber 3. The roller stopping mechanism D includes a base 41 in the form of a rectangular plate which is fixed to the floor 2a. A pair
25 of rectangular stationary roller stoppers 42 and 43 are fixed to the upper surface of the base 41. The stationary roller stoppers 42 and 43 are aligned parallel to the path

of at least one of the rollers 9 with a known distance from each other. Although the stationary roller stoppers 42 and 43 shown are welded to the upper surface of the base 41, they may be fixed to the base 41 by means of bolts or screws, or may be integral to the floor 2a.

A rectangular movable roller stopper 44, the width of which is substantially equal to the distance between the stationary roller stoppers 42 and 43, is disposed between the stationary roller stoppers 42 and 43 so as to extend into or draw back out of the path of the roller 9, both the sides of the movable roller stopper 44 sliding along the opposing sides of the stationary roller stoppers 42 and 43. An upright movable pivot 45, which is movable relative to the base 41, is fixed to the distal end of the upper surface of the movable roller stopper 44.

A third triangular lever 46 is hinged to the base 41 at one apex thereof via a stepped shaft 47 so as to connect the rear end of the connecting rod 40 to the distal end of the movable roller stopper 44. The upper portion of the stepped shaft 47 is threaded to receive a nut 48. Thus, the nut 48 prevents the third triangular lever 46 from disengaging from the stepped shaft 47.

Another apex of the third triangular lever 46 includes an elongate slot 49 into which a movable pivot 40a fits loosely. The remaining apex of the third triangular lever 46 includes another elongate slot 50 into which the movable pivot 45 fits loosely.

As described above, the movable roller stopper 44 draws back out of the path of the roller 9 when the movable roller stopper operating source rod 34 is in its upper position and on the other hand, extends into the path of the roller 9 when the movable roller stopper operating source rod 34 is in its lower position, because the movable roller stopper operating source rod 34 and the movable roller stopper 44 are connected to each other via the second triangular lever 37, the connecting rod 40 and the third triangular lever 46.

The operation of the interlock B will be described hereinafter.

In Fig. 3, when the operating handle 35 is in its lower limit position so as to actuate the dual lever 29 to its solid-lined position, the earthing switch operating rod 23 is in its rear limit position as shown in solid lines and the movable roller stopper operating source rod 34 is in its upper limit position. Thus, the earthing switch 18 is opened so that the movable blade 20 is out of contact with the stationary blade 19 and the roller stopping mechanism D is inoperative so that the movable roller stopper 44 is withdrawn from the path of the roller 9, as shown in Fig. 4. In this state, the circuit breaker 8 can be moved to the electrically disconnected position shown in phantom lines in Fig. 1 or past that position outside of the cabinet 2 and on the other hand, may be moved from the positions mentioned above to the electrically connected

position shown in solid lines in Fig. 1.

On the other hand, when the operating handle 35 is pivoted from the lower limit position to the upper limit position shown in phantom lines in Fig. 3 so as to pivot the dual lever 29 to its phantom-lined position, the earthing switch operating rod 23 is actuated to its forward limit position as shown in phantom lines in Fig. 3 and the movable roller stopper operating source rod 34 is lowered in its lower limit position. Thus, the earthing switch 18 is closed so that the movable blade 20 is contact with the stationary blade 19, and the roller stopping mechanism D is operative so that the movable roller stopper 44 extends into the path of the roller 9, as shown in Fig. 5. In this state, the circuit breaker 8 which is being moved from the electrically disconnected position or out of the cabinet 2 to the electrically connected position is blocked from reaching the electrically connected position, because the roller 9 abuts the movable roller stopper 44 which is supported by the stationary roller stoppers 42 and 43.

The movable roller stopper 44 blocking the roller 9 is supported by the stationary roller stoppers 42 and 43, the sides of the movable roller stopper 44 contacting the opposing sides of the stationary roller stoppers 42 and 43. Thus, the load applied to the movable roller stopper 44 is offset by the reaction applied to the movable roller stopper 44 by the stationary roller stoppers 42 and 43.

The slight transverse movement of the movable

roller stopper 44 which occurs because of the impact of the roller 9 against the movable roller stopper 44 is offset by the relation, illustrated in Fig. 5, between the movable pivot 45 and the elongate slot 50. Thus, the impact will not be transmitted to the third triangular lever 37.

Additionally, the slight longitudinal movement of the movable roller stopper 44 which occurs because of the impact of the roller 9 against the movable roller stopper 44 is offset by the relation, illustrated in Fig. 5, between the movable pivot 40a and the elongate slot 49. Thus, the impact will not be transmitted to the connecting rod 40.

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CLAIMS:

1. Metal-clad switchgear including:

a floored cabinet which has a vertical partition defining a circuit breaker chamber;

a pair of disconnectors fixed to the vertical partition;

a load bus;

an earthing switch for earthing a load circuit connected to the load bus;

an earthing switch actuating mechanism including

an earthing switch operating rod having one end connected to the earthing switch;

a circuit breaker including a pair of connecting rods and a plurality of rollers arranged to roll along the floor of the cabinet so as to enable the circuit breaker to be moved into and out of the circuit breaker chamber to electrically connect and disconnect each connecting rod with an associated one of the disconnectors;

a mechanical interlock between the circuit breaker and the earthing switch for preventing the circuit breaker from attaining its electrically connected position when the earthing switch is closed, wherein the mechanical interlock comprises:

a pair of elongate stationary roller stoppers fixed in spaced substantially parallel relationship.



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with each other to the floor of the cabinet, the stationary roller stoppers lying outside the path of the rollers;

an elongate movable roller stopper, having substantially the same width as the spacing between the stationary roller stoppers, disposed in the spacing, the movable roller stopper being arranged to be extended into and drawn back out of the path while being supported by the stationary roller stoppers; and

a link mechanism interlocking the earthing switch actuating mechanism and the movable roller stopper, the link mechanism being arranged to extend the movable roller stopper into the path when the earthing switch is closed to cause the movable roller stopper to block the path of at least one of the rollers.

2. Metal-clad switchgear as claimed in claim 1, in which the movable roller stopper has a first movable pivot and the link mechanism comprises a connecting rod which has a second movable pivot and which extends longitudinally near the floor within the cabinet and is longitudinally shiftable, and a lever, which includes first and second elongate openings and is supported by a pivot fixed stationary relative to the floor so as to be horizontally pivotable, and which connects the connecting rod and the movable roller stopper, the connecting



rod and the lever being connected to each other by means of engagement between the first elongate opening and the second movable pivot, and the movable roller stopper and the lever are connected to each other by means of engagement between the second elongate opening and the first movable pivot.

3. Metal-clad switchgear as claimed in claim 2, in which when the movable roller stopper extends into the path, the first movable pivot is not in contact with either of the ends of the second elongate opening which is substantially transverse to the longitudinal axis of the movable roller stopper, and the second movable pivot is not in contact with either of the ends of the first elongate opening which is substantially parallel to the longitudinal axis of the movable roller stopper.

4. A metal enclosed switchgear as claimed in claim 2 or claim 3, in which the operating link mechanism comprises a movable roller stopper operating source rod which is perpendicular to the floor and is vertically translatable, and a dual lever which has two operating ends and is pivotable by means of an operating handle, one of the operating ends being pivotably connected to the upper end of the movable roller stopper operating source rod and the other operating end being pivotably connected to the other end of the earthing switch operating rod.



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5. Metal-clad switchgear substantially as herein described with reference to, and as illustrated by, Figures 3 to 6 of the accompanying drawings.
