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MOTORIZED HIGH VOLTAGE IN-LINE DISCONNECT SWITCH WITH SOLAR PANEL ICE SHIELDS

Abstract

A high voltage motorized in-line air break disconnect switch having a rotating switch blade. The high voltage in-line switch including a solar panel ice shield unit. The solar panel ice shield unit including at least one solar panel operatively attached to an electric power line conductor. The solar panel ice shield unit configured to shield the moving contact end of the elongated switch blade from ice build-up when the high voltage motorized in-line air break disconnect switch is in the final open non-conductive switch position. The solar panel ice shield unit configured to collect more solar energy for electric charging of the battery. A solar panel ice shield unit support frame is configured to support the at least one solar panel and is configured to prevent corona. Additional solar panel units, not used as ice shields, can be attached to the electric power line conductor for collecting additional solar energy.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application claims the benefit of U.S. Provisional Application No. 63/551,227 filed Feb. 8, 2024, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] The present invention relates generally to an air break disconnect switch for high voltage electrical applications and, more particularly, to a motorized in-line high voltage air break disconnect switch that mounts in-line with a transmission line conductor without the need of a group operated switch with associated ground supported mounting structure. Such a motorized high voltage in-line disconnect switch hangs from and is supported by its associated transmission line.

[0003] A motorized high voltage in-line air break disconnect switch can be used to sectionalize long transmission lines, disconnect lines from substations, serve as a line tap switch, and serve as a temporary maintenance switch, for example. It allows for easy, cost efficient sectionalizing of high voltage transmission lines and isolation in high voltage substations.

[0004] One example of such a motorized high voltage in-line air break disconnect switch is disclosed in U.S. Pat. No. 9,881,755 B1 by Charles M. Cleaveland issued on Jan. 30, 2018, to Cleaveland/Price Inc., the present assignee, entitled “Motorized High Voltage In-Line Disconnect Switch With Hand-Held Communication System to Prevent Unwanted Operation”. This switch includes an elongated strain insulator supporting an elongated rotating switch blade having a hinge contact end and a break jaw contact end. The rotating switch blade is rotatable at the hinge contact end during opening and closing of the switch. The switch includes a battery powered motor connected to an output shaft to cause the hinge end of the switch blade to rotate when energized to open or close the switch. A communication system actuates the motor to cause the switch to open and close as desired. This patent discloses embodiments of a vertical break and a side break high voltage in-line motorized air break disconnect switch. Both the vertical break and side break switches include an elongated switch blade that is rotatable at one end of the switch blade, i.e., about the hinge end.

[0005] Another example of such a motorized high voltage in-line air break disconnect switch including a hinge mounted rotating switch blade is disclosed in U.S. Pat. No. 9,966,207 B1 by Charles M. Cleaveland issued May 8, 2018, to Cleaveland/Price Inc., the present assignee, entitled “Motorized High Voltage In-Line Disconnect Switch with Communication System Controls”. This switch includes a rotating switch blade that is operated by a communication system controlled battery powered motor that may include a switch mounted communication device, such as a radio which is controlled by another such communication device located in an electric utility control room to open and close the switch. This patent also discloses embodiments of a vertical break and a side break high voltage in-line motorized air break disconnect switch. Both the vertical break and side break switches include an elongated switch blade that is rotatable at one end of the switch blade, i.e., about the hinge end.

[0006] The said U.S. Pat. No. 9,881,755 B1 and the said U.S. Pat. No. 9,966,207 B1 are both incorporated herein by reference in their entireties as though fully set forth. Information regarding the installation, operations, adjustment, and many other aspects of the switches disclosed in said U.S. Pat. No. 9,881,755 B1 and said U.S. Pat. No. 9,966,207 B1 is provided in the present assignee's, Cleaveland/Price Inc., publication identified as Cleaveland/Price Instruction Book IB-

AA10-169A.3, August 2023, entitled “AUTOLINE® In-Line Motor Operated Switch 69 kV-230 kV-2000 AMP Installation and Operating Instructions Type ILO-MV”. AUTOLINE® is a U.S. registered trademark of the present assignee, Cleaveland/Price Inc. The said Cleaveland/Price Instruction Book IB-AA10-169A.3, August 2023, entitled “AUTOLINE® In-Line Motor Operated Switch 69 kV-230 kV-2000 AMP Installation and Operating Instructions Type ILO-MV” is incorporated herein by reference in its entirety as though fully set forth.

[0007] The present invention relates to an improvement to the motorized high voltage in-line air break disconnect switches disclosed in said U.S. Pat. No. 9,881,755 B1 and said U.S. Pat. No. 9,966,207 B1, which are currently being manufactured by the present assignee, Cleaveland/Price Inc. At the present time these battery operated motorized switches, which are solar powered, have limited application in use to the southern portion of the United States of America where there is ample sun, since these switches only have three solar panels, attached to a motor housing enclosing a battery and a battery operated motor, that keep the battery charged.

[0008] The present assignee's motorized high voltage in-line air break disconnect switches as disclosed in said U.S. Pat. No. 9,881,755 B1 and said U.S. Pat. No. 9,966,207 B1, hang on the high voltage transmission line and can be opened or closed by radio command to disconnect the power or reroute the power to another load. These in-line switches must be able to open or close the high voltage circuit in all kinds of weather and specifically in ice conditions.

[0009] To operate reliably under ice conditions, the present assignee's motorized high voltage in-line air break disconnect switches, as disclosed in U.S. Pat. Nos. 9,881,755 B1 and 9,966,207 B1, have been provided with ice shields that keep the open and close electric contacts of the switch from being covered with thick ice, such as ¾ inch to 1 inch, and uses flat pan-like plates to shield the switch blade mating contacts from ice as shown in FIG. **2**.

[0010] It is therefore an object of the present invention to provide an improved high voltage in-line air break disconnect switch that can operate reliably under ice conditions, by providing the necessary ice shielding that keeps the open and close electric contacts from being covered with thick ice and also, at the same time, providing the additional solar power needed for operating the in-line switch in northern climates where there is less sun energy available.

SUMMARY OF THE INVENTION

[0011] The object of the invention is achieved by the elongated rotating motorized in-line high voltage air break disconnect switch of the present invention comprising a new unique solar panel ice shield unit including an improved ice shield with integral solar panels operatively mounted on the transmission line above the moving contact end of the elongated switch blade when the switch is in the final open electrically non-conductive switch position. The disclosed solar panel ice shield unit is attached directly to and supported by the transmission cable for northern climates, instead of the flat pan-like plate used solely for ice shielding as described above. Additionally, the motorized in-line high voltage air break disconnect switch may comprise at least one or more additional solar panel units that do not shield ice from the moving contact end of the elongated switch blade when the switch is in the final open electrically non-conductive switch position, but can provide additional solar energy if needed for northern climates, and which can also be attached directly to and supported by the transmission cable. Up to four such additional solar panel units is typical.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] For a better understanding of the invention reference may be made to the accompanying drawings exemplary of embodiments of the invention, in which:

[0013] FIG. **1** shows a perspective view of a vertical break embodiment of the motorized in-line switch as disclosed in the said U.S. Pat. No. 9,881,755 B1 and said U.S. Pat. No. 9,966,207 B1;

[0014] FIG. **2** shows a perspective view of the same switch as shown in FIG. **1**, but with flat pan-like plate ice shields for the open and closed positions of the switch with the switch shown closed;
[0015] FIG. **3** shows a perspective view of the same switch as shown in FIG. **2**, partially broken away showing the switch motor, the switch motor battery, and the switch hinge end, and showing the flat pan-like plate ice shields for the open and closed positions of the switch, with the switch open and one of the flat pan-like plate ice shields covering the open blade contacts;
[0016] FIG. **4** shows a perspective view of the same switch as shown in FIG. **3** with the disclosed solar panel ice shield unit of the present invention clamped to the transmission line for supplying additional solar energy and for shielding the open blade contacts from ice build-up;
[0017] FIG. **5** shows a perspective view of an enlarged detail of the solar panel ice shield unit shown in FIG. **4**, showing how the solar panel ice shield unit attaches to the transmission line with cable clamps, and showing the D.C., i.e., direct current, conductors that feed current from the solar panel ice shield unit to the battery within the motor housing; and,
[0018] FIG. **6** shows a perspective view of the same switch as shown in FIG. **4**, but with additional solar panel unit units, not used for ice shielding, also attached directly to, and supported by the transmission line, the additional solar panel units used for collecting more solar energy for the far north areas. Up to four additional solar panel units are possible as needed for more energy.

DETAILED DESCRIPTION OF THE INVENTION

[0019] A vertical break motorized high voltage in-line air break disconnect switch **10** is shown in FIGS. **1**, **2**, and **3**, as disclosed in the said U.S. Pat. No. 9,881,755 B1 and said U.S. Pat. No. 9,966,207 B1. The present invention is also applicable to a side break motorized high voltage in-line air break disconnect switch which is also disclosed in the said U.S. Pat. No. 9,881,755 B1 and said U.S. Pat. No. 9,966,207 B1. Although, such a side break switch is not shown in the present drawings.
[0020] The motorized elongated rotating high voltage in-line air break disconnect switch **10** as shown in FIGS. **1** and **2** is shown in the closed electrically conductive position. FIG. **3** shows the vertical break disconnect switch **10** in the open electrically non-conductive position. The switch **10** as shown in FIG. **3**, with the cut-away view, includes a motor housing **12** enclosing a battery operated switch motor **13**. Solar panels **14***a*, **14***b*, and **14***c* are operatively attached to the motor housing **12** for charging the switch motor battery **15** enclosed in the housing **12**. The in-line disconnect switch **10** includes a polymer elongated strain insulator **16** for support and to provide electric insulation for the open air gap between break jaw **19** and the housing **12**. The switch **10** includes a vacuum interrupter **22** to interrupt load current without electric arcing as the switch opens at the break jaw contact **19**. The switch **10** includes a hinge mounted elongated rotating switch blade **18** that includes a moving contact end **25** including moving contact **21** and moving arc horn **23***b*. The moving contact end **25** contacts the break jaw contact **19** in the closed conductive switch blade position **33***a* as shown in FIG. **1**.
[0021] FIG. **3** shows the rotating switch blade **18** rotates about a hinge end **20** of the rotating switch blade **18** which is supported by the elongated strain insulator **16**. The elongated rotating switch blade **18** in the electrically conductive switch position extends in parallel relationship with the elongated strain insulator **16**.
[0022] As shown in FIG. **1**, a transmission line **24** has been cut, resulting in two transmission line ends **26***a*, **26***b*. Each transmission line end **26***a*, **26***b* is respectively attached to strain cable fittings **28***a*, **28***b* which support the entire motorized switch **10** comprising strain insulator **16**, the attached switch blade **18**, the motor housing **12**, the vacuum interrupter **22**, and other elements of the switch **10**. The vacuum interrupter **22** includes an actuating arm **23***a*. The moving arc horn **23***b* is attached to the moving switch blade **18**.
[0023] FIG. **2** shows a pan ice shield **30** covering the break jaw **19** and the moving arc horn **23***b* to prevent ice build-up on these elements. The pan ice shield **30** is shaped like a pan-like plate. FIG. **3** also shows a similarly shaped pan ice shield **32** covering the moving contact end **25** of the switch

blade **18** in a final open non-conductive switch blade position **33***b* to prevent ice build-up on the moving contact **21** and on the moving arc horn **23***b*. The pan ice shields **30** and **32** are typically made of aluminum. For further details of the motorized in-line switch **10** from 69 kV to 230 kV, reference may be made to the above-referenced present assignee's, Cleaveland/Price Inc., publication identified as Cleaveland/Price Instruction Book IB-AA10-169A.3, August 2023, entitled “AUTOLINE® In-Line Motor Operated Switch 69 kV-230 kV-2000 AMP Installation and Operating Instructions Type ILO-MV”.

[0024] FIG. **4** shows one embodiment of the motorized high voltage in-line air break disconnect switch **10** of the present invention. The same reference numerals used in FIGS. **1**, **2**, and **3** to identify various components and details of the currently manufactured in-line switch **10** are also used in FIG. **4** to identify the same components and details. The in-line switch **10** shown in FIG. **4** shows the in-line switch **10** as shown in FIG. **3**, but instead of the pan ice shield **32** as shown in FIG. **3**, it has been replaced according to the present invention with solar panel ice shield unit **34**.

[0025] The solar panel ice shield unit **34** includes at least one ice shield solar panel. In one embodiment of the invention three ice shield solar panels **34***a*, **34***b*, and **34***c* are arranged as shown in FIG. **4**, in order to shield the moving contact end **25** (hidden under solar panel ice shield unit **34**) of the switch blade **18** from harmful ice build-up, when the switch **10** is in the final open non-conductive position. The three ice shield solar panels **34***a*, **34***b*, and **34***c* are desirably arranged in an inverted V-configuration, as shown in FIG. **4**, configured to act as an ice shield for the moving contact end **25** of the switch blade **18**, while simultaneously configured to capture solar energy. The moving contact end **25** is hidden by the solar panel ice shield unit **34** in FIG. **4**, but the moving contact end **25** is shown in FIG. **3**. The three ice shield solar panels **34***a*, **34***b*, and **34***c* for a 69 kV to a 230 KV for such a motorized in-line switch may have the same dimensions.

[0026] The solar panel ice shield unit **34** may also include a solar panel ice shield unit support frame **40** for supporting the three ice shield solar panels **34***a*, **34***b*, and **34***c*. Each ice shield solar panel **34***a*, **34***b*, and **34***c* is respectively, preferably, mounted on a plate **35***a*, **35***b*, and **35***c*, which is attached to the solar panel ice shield unit support frame **40**, as can be seen in FIG. **5**. The plates **35***a*, **35***b*, **36***c* may be made of aluminum and welded to the solar panel ice shield unit support frame **40**, for example.

[0027] The three ice shield solar panels **34***a*, **34***b*, **34***c* may have a combined maximum electric output of 50 watts. The solar panel ice shield unit support frame **40** can be typically made of aluminum tube and serves as a corona ring to prevent electric stress at high voltage. The solar panel ice shield unit support frame **40** can be attached by conductor clamps **36***a*, **36***b* to the transmission line **24**, as shown in FIG. **5**. D.C. cables **38***a*, **38***b* feed direct current to energize the switch motor battery **15** for powering the switch motor **13** housed in the motor housing **12**. The D.C. cables **38***a*, **38***b* can be held by their terminations between the connection at the respective ice shield solar panels **34***a*, **34***b*, and **34***c* and the battery **15**. The terminations are not shown in the drawings.

[0028] FIG. **6** shows another embodiment of the present invention, where the in-line switch **10** includes an additional solar panel unit **42** used for collecting more sun energy when the in-line switch **10** is installed in the north areas of the United States, for example. The additional solar panel unit **42** is not used for ice shielding. The additional solar panel unit **42** includes three non-ice shield solar panels **42***a*, **42***b*, and **42***c*, for example, which may be identical to the solar panels **34***a*, **34***b*, and **34***c* used for the solar panel ice shield unit **34** described above. Each non-ice shield solar panel **42***a*, **42***b*, and **42***c* is respectively preferably mounted on non-ice shield solar panel mounting **43***a*, **43***b*, and **43***c*, which are attached to the additional solar panel unit support frame **44**, as can be seen in FIG. **6**. The non-ice shield solar panels **42***a*, **42***b*, and **42***c* also may be attached to transmission line **24** by the additional solar panel unit support frame **44** in the same manner as described above for solar panel ice shield unit solar panels **34***a*, **34***b*, **34***c*. The additional solar panel unit support frame **44** may be attached to the transmission line **24** by similar additional clamps **46***a*, **46***b* in the same manner as described above for the solar panel ice shield clamps **36***a*,

36*b*. The same D.C. cables used for the solar panel ice shield unit **34** described above can also be used to feed direct current from the additional solar panel unit **42** to the switch motor battery **15**.

[0029] The three non-ice shield solar panels **42***a*, **42***b*, and **42***c* of the additional solar panel unit **42** may also be arranged in the same inverted V-configuration as shown in FIG. **6** for the ice shield solar panels **34***a*, **34***b*, and **34***c* of the solar panel ice shield unit **34**. Up to four additional solar panel units **42** is possible. Of course, the ice shield solar panel unit **34** and one or more of the non-ice shield additional solar panel units **42** may be used in addition to the solar panels attached to housing **12** to charge the battery **15**, for increased charging in the north United States.

LIST OF REFERENCE NUMERALS

[0030] **10** elongated rotating motorized high voltage in-line air break disconnect switch [0031] **12** motor housing [0032] **13** switch motor [0033] **14***a* motor housing solar panel [0034] **14***b* motor housing solar panel [0035] **14***c* motor housing solar panel [0036] **15** switch motor battery [0037] **16** polymer elongated strain insulator [0038] **18** hinge mounted elongated rotating switch blade [0039] **19** break jaw contact terminal [0040] **20** hinge end of **18** [0041] **21** moving contact of **18** [0042] **22** vacuum interrupter [0043] **23***a* actuating arm of **22** [0044] **23***b* moving arc horn [0045] **24** transmission line [0046] **25** moving contact end of **18** [0047] **26***a* transmission line end [0048] **26***b* transmission line end [0049] **28***a* strain cable fitting [0050] **28***b* strain cable fitting [0051] **30** pan ice shield jaw end [0052] **32** pan ice shield for final open blade position [0053] **33***a* closed conductive switch blade position [0054] **33***b* final open non-conductive switch blade position [0055] **34** solar panel ice shield unit [0056] **34***a* ice shield solar panel of **34** [0057] **34***b* ice shield solar panel of **34** [0058] **34***c* ice shield solar panel of **34** [0059] **35***a* solar panel mounting plate [0060] **35***b* solar panel mounting plate [0061] **35***c* solar panel mounting plate [0062] **36***a* solar panel ice shield unit transmission line conductor clamp [0063] **36***b* solar panel ice shield unit transmission line conductor clamp [0064] **38***a* D.C. cable conductor in circuit with switch motor battery **15** [0065] **38***b* D.C. cable conductor in circuit with switch motor battery **15** [0066] **40** solar panel ice shield unit support frame [0067] **42** additional solar panel unit [0068] **42***a* non-ice shield solar panel of **42** [0069] **42***b* non-ice shield solar panel of **42** [0070] **42***c* non-ice shield solar panel of **42** [0071] **43***a* non-ice shield solar panel mounting plate [0072] **43***b* non-ice shield solar panel mounting plate [0073] **43***c* non-ice shield solar panel mounting plate [0074] **44** additional solar panel unit support frame [0075] **46***a* additional solar panel unit transmission line conductor clamp [0076] **46***b* additional solar panel unit transmission line conductor clamp

[0077] Of course variations from the foregoing embodiments are possible without departing from the scope of the invention.

Claims

1. A high voltage motorized in-line air break disconnect switch operatively supported and suspended by and mounted in-line with an electric power line conductor, the high voltage motorized in-line air break disconnect switch having an open electrically non-conductive position and a closed electrically conductive position, the high voltage motorized in-line air break disconnect switch comprising: an elongated strain insulator operatively supported and suspended by and between a first cut end and a second cut end of the electric power line conductor, an elongated rotating switch blade including a hinge contact end and a moving contact end, the elongated rotating switch blade in the closed electrically conductive switch position in parallel relationship with the elongated strain insulator, the hinge contact end of the elongated rotating switch blade supported by the elongated strain insulator, a hinge contact terminal in operative electric circuit arrangement with the elongated rotating switch blade at the hinge contact end thereof, the hinge contact terminal including an integral hinge member and a break jaw contact terminal including an integral break jaw operatively supported by the elongated strain insulator at opposite ends thereof, the moving contact end of the elongated rotating switch blade in operative electric circuit arrangement with the break jaw contact terminal when the high voltage motorized in-line air break disconnect switch is in the closed conductive position, the elongated rotating switch blade in the open electrically non-conductive switch position rotatable about the integral hinge member to a final open electrically non-conductive switch position in parallel relationship with the electric power line conductor, a first electrical connection in operative electric circuit arrangement between the electric power line conductor and the hinge contact terminal and a second electrical connection in operative electric circuit arrangement between the electric power line conductor and the break jaw contact terminal, a motor in operative arrangement with the hinge contact end of the elongated rotating switch blade to rotate the elongated rotating switch blade upon the motor actuation into operative electric closed circuit arrangement with the break jaw contact in the closed conductive switch position and to rotate upon motor actuation out of operative electric closed circuit arrangement with the break jaw contact into the final open non-conductive switch position, a motor housing operatively supported by the electric power line conductor proximate the hinge end, the motor housing enclosing the motor, the motor housing enclosing at least one solar charged battery for supplying energy to the motor, the motor housing including solar panels operatively attached to the exterior of the motor housing for solar charging of the at least one battery, a solar panel ice shield unit including at least one ice shield solar panel operatively attached to the electric power line conductor and the at least one ice shield solar panel connected in electrical operative arrangement with the at least one solar charged battery and the motor for increased solar charging of the battery, and, the solar panel ice shield unit configured to shield the moving contact end of the elongated switch blade from ice build-up when the high voltage motorized in-line air break disconnect switch is in the final open electrically non-conductive switch position.

2. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 1, further comprising a solar panel ice shield unit support frame configured to support the at least one ice shield solar panel.

3. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 2, wherein the solar panel ice shield unit support frame includes round tubular frame material configured to prevent electric corona.

4. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 2, wherein the solar panel ice shield unit support frame is in operative attachment to the electric power line conductor.

5. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 1, further comprising direct current cables in operative electrical connection between the at least one ice shield solar panel and the at least one battery.

6. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 2, further comprising at least one clamp configured to clamp the electric power line conductor to the solar panel ice shield unit support frame.

7. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 2, wherein the solar panel ice shield unit support frame is made of aluminum.

8. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 1, further comprising at least one non-ice shield additional solar panel unit including at least one non-ice shield solar panel, the at least one non-ice shield additional solar panel unit operatively attached to the electric power line conductor, the at least one non-ice shield additional solar panel unit configured to collect more solar energy for electric charging of the at least one battery.

9. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 8, further comprising an additional non-ice shield solar unit support frame configured to support the at least one non-ice shield additional solar panel, the additional non-ice shield solar unit support frame in operative attachment to the electric power line conductor.

10. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 8, further comprising direct current cables in operative electrical connection between the at least one non-ice shield additional solar panel and the at least one battery.

11. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 9, further comprising at least one additional clamp configured to clamp the electric power line conductor to the additional non-ice shield solar panel unit support frame.

12. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 9, wherein the non-ice shield solar panel unit support frame is made of aluminum.

13. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 8, wherein the solar panel ice shield unit and the at least one non-ice shield additional solar panel unit are arranged adjacent to each other proximate the moving contact end of the elongated rotating switch blade in the final open non-conductive switch blade position.

14. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 1, wherein the solar panel ice shield unit further comprises at least one ice shield solar panel mounting plate, each ice shield solar panel mounting plate having one of the at least one ice shield solar panels operatively attached.

15. The conductor suspended high voltage motorized in-line air break disconnect switch of claim 9, wherein the at least one non-ice shield additional solar panel unit each further comprises at least one non-ice shield solar panel mounting plate, each non-ice shield solar panel mounting plate having one of the at least one non-ice solar panels operatively attached.