Oct. 22, 1957 A. C. SCHWAGER 2,810,805

CIRCUIT INTERRUPTING AND ISOLATING SWITCH

Filed Oct. 3, 1955 2 Sheets-Sheet 1

Fig. 6.

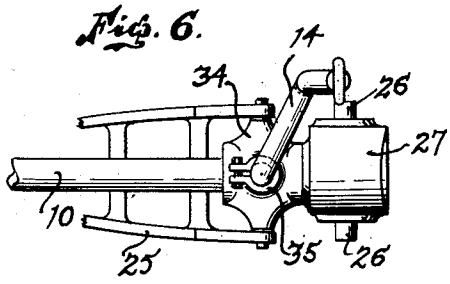
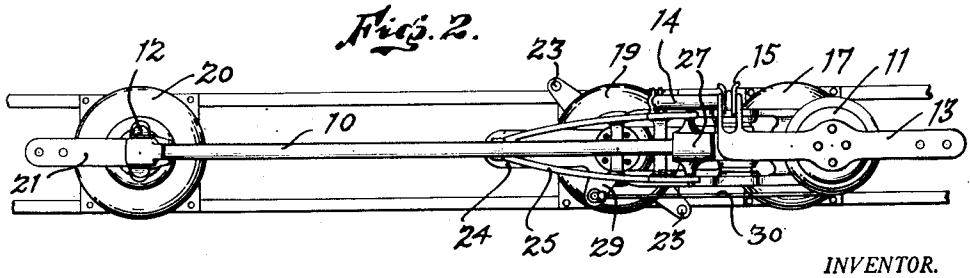


Fig. 1.

Fig. 2.



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Fig. 3.

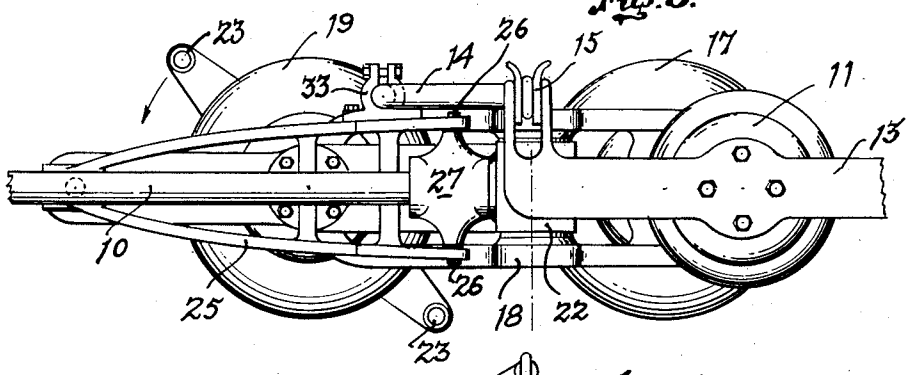


Fig. 4.

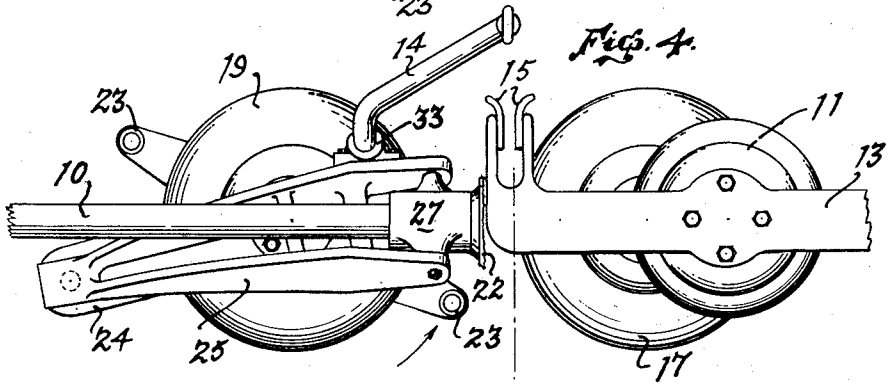
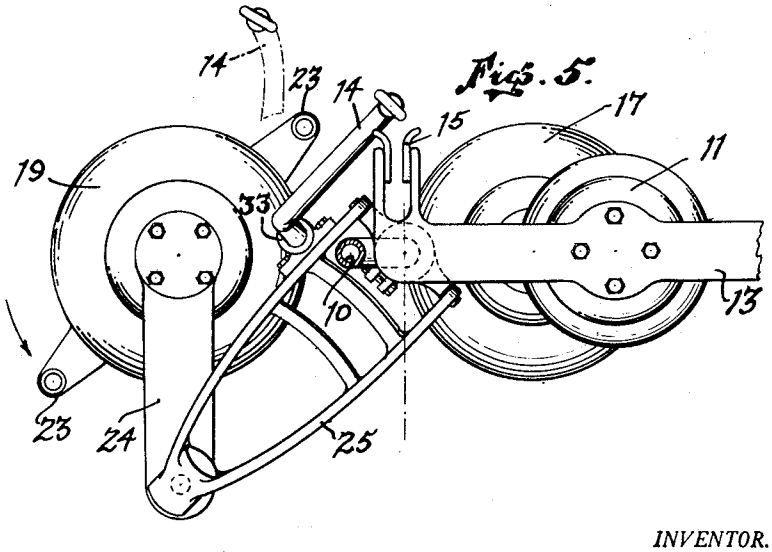


Fig. 5.



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United States Patent Office 2,810,805 Patented Oct. 22, 1957

2,810,805

CIRCUIT INTERRUPTING AND ISOLATING SWITCH

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Application October 3, 1955, Serial No. 538,145

15 Claims. (Cl. 200—145)

This invention relates generally to air-break switches, and more particularly to a power line circuit isolating switch assembly of the type employing an air-break switch and an arc suppressing circuit interrupter which will open a power line circuit irrespective of fault currents, load currents, capacitor and line charging currents, magnetizing currents, etc., without an external display of an arc or flame.

The main object of my invention is to provide a disconnecting switch capable of interrupting load or charging currents and fault currents of a transmission line without the external display of an arc or flame.

Another object of my invention is to provide a circuit interrupting device capable of interrupting load currents and having a form suitable for movement as a whole into and out of engagement with at least one line terminal so as to insert an appropriate isolating air-gap in the circuit following circuit interruption.

A further object of the invention is to provide a circuit protective device embodying two serially related circuit interrupting units capable of interrupting load and overload currents, and at least one of which is movable out of the circuit for inserting a circuit isolating air-gap therein.

A further object of the invention is to provide a load break disconnecting switch wherein a movable switch blade operates to establish an air-break in the circuit and a circuit breaker with completely enclosed separable contacts operates to interrupt current flow and open the circuit in response to the initial movement of the switch blade to its circuit isolating position.

A further and more specific object of the invention is to provide a load break disconnecting switch in which the switch blade is connected at least during its opening movement with an arc extinguishing circuit breaker for causing current normally flowing through the switch to be transferred to the arc extinguishing circuit and in which the arc extinguishing contacts are actuated to an open circuit position upon an initial opening movement of the switch blade.

Finally and more specifically another object of my invention is to provide a novel circuit isolating switch means embodying an arc suppressing circuit breaker of moderate current carrying capacity and an air-break disconnecting switch having a blade of the so-called beavertail type, in which a shunt circuit forming means operable upon a final twisting of said switch blade into its circuit closed position establishes a current carrying shunt circuit in parallel with said circuit breaker and upon an initial twisting of said switch blade preparatory to a pivotal circuit disconnecting operation said shunt circuit is opened.

Another object of my invention is to provide a disconnecting switch embodying trip-free circuit breaker in series circuit with a disconnecting switch blade of the type having both a pivotal and a twisting motion preceding and following respectively a circuit opening and a

circuit closing pivotal movement of said switch blade, in which means timed with the twisting motion of said switch blade operates to respectively open and close the circuit through said circuit breaker as said switch blade is twisted out of and into its circuit closed position with respect to its terminal contact.

Other objects and advantages of the invention will be in part evident to those skilled in the art and in part pointed out hereinafter in connection with the accompanying drawings wherein there is shown by way of illustration and not of limitation a preferred embodiment thereof.

In the drawing:

Figure 1, is a side elevation of a switch embodying the invention,

Figure 2, is a plan view of the switch, as shown in Figure 1 of the drawings,

Figure 3, is an enlarged plan view corresponding to that portion as shown in Figure 2 of the drawings,

Figures 4 and 5 are fragmentary views similar to Figure 3 showing the switch blade operating mechanism in different operating positions, and

Figure 6, is a fragmentary view showing a modified embodiment of the invention.

In the past, numerous air-break switches have been designed to operate in conjunction with an arc rupturing circuit breaker either installed and associated therewith or incorporated in the structure of the air-break switch blade. Such arc interrupting devices are at the present time in the form of circuit breakers having contacts that are immersed in oil, or subjected to an oil blast, a gas blast, or are of the explosion type. Devices of this character require the introduction of a large break or contact separation, which may vary from several inches to several feet, and consequently they also require a complicated and massive operating mechanism and usually operate with considerable external flame with its associated hazards. In addition to this the life of such circuit interrupting devices is limited, either due to carbonization of the oil or wear of their component parts, and consequently they require frequent inspection for maintenance and even replacement of parts.

In the transmission of electrical power, the disconnecting switch heretofore has been used mainly to isolate sections of a power transmission system from each other or for isolating a load circuit from an associated network. This switching operation in most instances necessarily had to be carried out under conditions of no-load on the circuit and even under no-load conditions, the high voltages now employed in power transmission systems produce charging currents of appreciable magnitude. In the past, attempts have been made to interrupt line charging currents and light load currents with disconnecting switches equipped with arcing horns and while certain of these disconnecting switches, particularly those of the low-voltage type, have successfully interrupted charging and small load currents, their use for this purpose is unsatisfactory as the exposed air-break arc drawn during the circuit opening operation may be blown across the line or to grounded parts thus causing a flow of fault currents.

While the objects of the present invention are capable of attainment with many present-day circuit interrupting devices, employing oil immersed arc interrupting contacts and other forms of arc confining and suppressing means, I am here illustrating my invention as embodying a circuit isolating air-break switch of the tail-twisting or beavertail type, in combination with a vacuum switch of novel construction, which latter is the subject matter of a copending application for patent Serial Number 571,923 filed March 16, 1956, and entitled, "High Voltage Circuit Interrupting Switch Means."

Briefly, and for the purpose of this disclosure, it may be stated that the vacuum circuit breaker employed by me has separable contacts that are enclosed within a hermetically sealed tube which is evacuated to the highest possible vacuum, for example, 10^6 mm. Hg or more. The arc quenching and insulating quality of the contact gap in a vacuum is extremely high and is in the order of one million volts per 0.1 inch of contact separation. In other words, when the contacts carrying an alternating current separate, a contact separation of about one-tenth of an inch will be sufficient to open the circuit under all conditions of operation. When employed in the manner here contemplated the vacuum switch has been found to produce an extremely efficient interruption of a high voltage circuit under both load and fault conditions.

With such a circuit breaker, interruption of the circuit always occurs at the first current zero following the separations of contacts and due to the high insulating value of the vacuum in the gap, re-strikes do not occur even under the most severe switching operations such as are met with in switching capacitor banks or in the opening of long line power transmission systems. Due to the complete absence of gas molecules around the contacts of such a circuit breaker, the arc formed is extremely small as compared with the arc produced in other types of circuit interrupting devices such as have been referred to herein-above. As a result there is accordingly very little deterioration of the contacts and consequently large capacitor banks can be switched several thousand and possibly several ten thousands of times. Such a vacuum switch can therefore be left in service for the lifetime of the associated equipment without requiring maintenance, replacement or repair.

Air-break switches of the type contemplated by this invention are usually built with continuous current ratings of from 600 to 1200 amperes and while vacuum switches can interrupt such currents and even higher values they become uneconomical if designed for such a continuous current carrying rating. The acceptable continuous current rating for vacuum switches is in the neighborhood of 100 to 200 amperes. Therefore in order to employ such a circuit breaker it is advisable to place the vacuum switch in shunt circuit with an associated current carrying conductor or auxiliary shunt forming switch blade, which will operate to carry the line current during normal closed circuit operation of the disconnecting switch. In this arrangement the auxiliary or shunt circuit forming blade is opened prior to a circuit interrupting operation of the vacuum switch and the vacuum switch is operated to interrupt the flow of current during the initial circuit opening operation of the main air-break disconnecting switch blade and preferably substantially simultaneously with a separation of the main switch blade and its line terminal contact.

For a more detailed description of the invention references now made to the accompanying drawings wherein there is shown an air-break disconnecting switch blade, designated by the numeral **10**, as operating in series circuit with an arc extinguishing circuit breaker **11**. The arc extinguishing circuit breaker **11** is of the vacuum insulated type such as is disclosed in J. E. Jennings Patent No. 2,740,869 dated April 3, 1956 and entitled, "Vacuum Switch." As shown the vacuum insulated circuit breaker **11** has axially aligned and cooperating contacts **7** and **8** which are mounted within an evacuated envelope **9**. The upper contact **7** in this instance is stationary and the lower contact **8** is movable between its cooperating limits as the circuit therethrough is opened and closed in the manner to appear hereinafter. The switch blade **10** engages a stationary switch blade contact terminal **12** and the circuit breaker **11** has a line terminal **13**. Extending upwardly from the switch blade **10** there is an auxiliary shunt circuit forming blade **14** which engages a terminal contact clip carried by the circuit breaker terminal **13**. In this instance the circuit breaker **11** is mounted upon a bracket **16** carried by an insulating stack **17** and the switch blade **10** is shown as pivotally mounted upon a bridging member **18** that extends from the top of the insulator stack **17** to a second insulator stack **19**. This insulator stack **19** is rotatable in the conventional manner as a means for operating the switch blade **10** into its open and closed circuit positions. A third insulator stack **20** carries a line terminal **21** and also the switch blade terminal contact **12** with which the switch blade **10** co-operates.

A feature of the invention resides in the utilization of a novel feature of the so-called beaver-tail twisting mechanism by which the switch blade **10** is rotated or twisted about its axis as it moves into and out of circuit forming engagement with its stationary contact terminal **12**. In this particular arrangement the switch blade **10** is carried by a supporting member **22** that is pivotally mounted upon the bridging member **18** and the upper end of the insulator stack **19** is shown as journaled in the bridging member **18** so that it may be rotated. At its lower end the insulator stack **19** has a double ended diametrically extending lever arm **23** by which this stack either alone or together with a corresponding stack of a similar switch or switches may be simultaneously operated. At its upper end the insulator stack **19** is also shown as having a radially extending arm **24** to the outer end of which there is connected a forked link **25**. This forked link is shown as spanning the switch blade **10** and as connected to trunnions **26** carried by a rotatable bearing **27** to which the switch blade **10** is attached. As will hereinafter appear, the auxiliary shunt circuit forming blade **14** is mounted directly upon one side of the forked link **25** and as this forked link **25** operates to impart a twisting motion to the switch blade **10** the auxiliary shunt forming blade **14** will be caused to swing laterally in a plane substantially at a right-angle to the plane in which the switch blade **10** pivots and out of contact with the switch clip **15**. To compensate for weight and to provide for balance and ease of operation the bridging member **18** is shown as encompassing a counter-balancing spring means **28**.

In order to justify the employment of an air-break disconnecting switch blade in combination with an inexpensive arc extinguishing circuit breaker, in the manner here described, instead of a conventional high-voltage circuit breaker with full load current capacity as in the past, it is essential that the circuit breaker of the combination be light in construction and operable with a simple and inexpensive operating mechanism. In the construction of a circuit breaker of the latter type the current carrying contacts will necessarily be of low current carrying capacity and consequently it is the practice to provide a circuit breaker short-circuiting shunt that will co-operate with the circuit breaker as a current carrying conductor when the disconnecting switch blade **10** is in its circuit closed position. To provide the above features I prefer to use a circuit controlling switch of the sealed vacuum insulated type, as such a switch has been found to have the capacity to carry the full line current for a short period of time without sacrificing its superior circuit interrupting ability. With such a switch having separable contacts hermetically sealed in an evacuated chamber it is also possible to obtain an arc free interruption of the circuit under all operating current conditions. To accomplish this, however, it is necessary that the auxiliary circuit forming blade **14** be rendered inoperative by disconnection with its contact clip **15** when the circuit is to be opened. In practice this disconnection in the shunt circuit should occur, in point of time, substantially simultaneously with or slightly prior to an actual break in the circuit between the switch blade **10** and its co-operative stationary terminal contact **12**.

The above arrangements except for the addition of the arc extinguishing circuit breaker **11** and its auxiliary

shunt circuit forming blade **14** may be considered to represent construction of practically any of the so-called beaver-tail types of air-break disconnecting switches in which the circuit isolating blade **10** is rotated or twisted into and out of engagement with its co-operating terminal contact, here designated by the numeral **12**. While I have shown only one such disconnecting switch with an associated circuit breaker it will be understood that two or more of these switches may be used in parallel on a power line and operated simultaneously by connecting links extending between the ends of the double-ended diametrically extending lever arm **23** carried by the rotatable insulator stack **19**. At the upper end of the insulator stack **19** and in addition to the radial arm **24** there is a shorter lever arm **29** to which there is universally connected a circuit breaker control rod **30** that operates with a reciprocating movement as the switch blade **10** is twisted and pivoted upon its support **22**. This operating rod **30** is shown as connected with a crank arm **31** that extends from and controls a circuit breaker contact operating mechanism **32** which may be of any conventional form. As will be pointed out in more detail in my co-pending application for patent the position and operating range of the lever arm **31** of the operating mechanism **32** is so related to the operations of the switch blade **10** that the circuit opening and circuit closing movements of the circuit breaker contacts will respectively occur as the disconnecting switch blade **10** is initially rotated or twisted preparatory to a circuit opening pivotal movement thereof and to close as the disconnecting switch blade **10** approaches or is being twisted into its final closed circuit position with respect to the stationary terminal contact **12**.

For a description on the operation of the invention, as here disclosed, reference is now made to Sheet–2 of the drawings wherein Figure 3 is a plan view showing the operating parts of the switch with the switch blade **10** in its closed circuit position as shown in Figures 1 and 2 of the drawings. Figure 4 shows the relative position of the blade twisting and operating mechanism during the blade twisting period of operation which occurs prior to the initial pivotal movement of the switch blade **10**. Figure 5 shows the position of the parts when the switch blade **10** reaches its full open circuit position. When the switch blade **10** is in its closed circuit position, as shown in Figures 1, 2 and 3 of the drawings, the shunt forming blade **14** will be in its normal operating position with its extending end in engagement with the contact clip **15** carried by the terminal **13**. At this time as indicated in Figure 3 the shunt circuit forming blade **14** will lie closely adjacent to the center line of the circuit breaker. Prior to the initial pivotal circuit opening operation of the switch blade **10**, as had been indicated hereinabove, the switch blade **10** will be twisted through a small angle. This will cause the beaver-tail end of the switch blade **10** to turn between the opposed contact surfaces of the terminal clip **12** to thus facilitate a separation of the blade **10** and the terminal contact **12**. This period of operation is important, particularly where switches of this character are exposed to where an accumulation of ice and snow thereupon might seriously interfere with a circuit opening operation of the switch. Simultaneously, with the twisting of the switch blade **10** in this manner, the shunt circuit forming blade **14** will have moved out of contact with the terminal clip **15** and into a position substantially corresponding to that shown in Figure 4. This movement of the shunt circuit forming blade **14** is explained by the fact that the forked ends of the link **25** which engage with the trunnions **26** upon the blade carrying member **27** tend to adjust themselves with respect to their universal connection with the lever arm **24**. This causes the blade carrying member **27** to turn about the axis of the blade **10**. In other words, the free end of the forked link **25** extends downwardly below the axis of the trunnions **26** and consequently as it is caused to follow around with its universal connection upon the lever on **24** one side of the forked link **25** will be put under tension while the other side will be under compression. This will cause the blade carrying member **27** to turn about its axis and produce the blade twisting operation. Then as the lever arm **24** continues to move around in its counterclockwise direction to the position as shown in Figure 5 of the drawings, the forked link **25** will again assume a substantially horizontal position and the shunt circuit forming blade **14** will have been carried back to a position closely adjacent to, but still out of contact with the switch clip **15** where it may if desired be protected by a suitable cover against the accumulation of ice and snow at this point when the switch is in the open circuit position. During this movement of the forked link from the position shown in Figure 4 to the position indicated in Figure 5 the shunt forming blade **14** will gyrate through a small arcuate path in which at one time it will reach an extreme outer position substantially corresponding with that indicated by dot and dash lines in Figure 5 of the drawing.

In the above I have described the shunt circuit forming blade **14** as mounted upon a bracket **33** carried by one side of the forked link **25**, but it is to be understood that while this arrangement appears to be preferred, the object of the invention can also be accomplished by mounting the shunt circuit forming blade **14** directly upon the pivotly mounted blade carrying member **34** as shown in Figure 6 of the drawings. In this latter arrangement the pivotly mounted blade carrying member **27** is shown as having an integrally cast split clamping socket **35** into which the lower end of the shunt circuit forming blade **14** is secured.

While I have, for the sake of clearness and in order to disclose the invention so that the same can be readily understood, described and illustrated specific devices and arrangements, I desire to have it understood that this invention is not limited to the specific means disclosed, but may be embodied in other forms and arrangements that will suggest themselves to persons skilled in the art. It is believed that this invention is new and all such changes as come within the scope of the appended claims are to be considered as part of this invention.

Having thus described my invention what I claim and desire to secure by Letters Patents is:

1. In a high voltage power line disconnecting device, the combination of a pivotally mounted air-break disconnecting switch having a blade of the beaver-tail type, a stationary terminal contact with which the beaver-tail of said switch blade engages with a twisting motion, means for twisting said switch blade as it moves into and out of engagement with said stationary terminal contact, a high voltage circuit breaker connected in series circuit with said switch blade having separable contacts enclosed in an arc confining chamber, an operating mechanism for moving the separable contacts of said circuit breaker into and out of contact with each other, means forming a shunt circuit around said circuit breaker when in its closed circuit position, and means responsive to the operation of said blade twisting means for controlling the operations of said shunt circuit forming means and said circuit breaker operating mechanism in timed relation with the twisting operations of said switch blade, whereby said circuit breaker contacts will operate to interrupt the circuit through said disconnecting switch blade during the twisting operation thereof and prior to disengagement of said switch blade with said stationary terminal contact.

2. In a high voltage power line circuit disconnecting device, the combination of a pivotally mounted air-break disconnecting switch having a blade of the beaver-tail type, a stationary terminal contact with which the beaver-tail of said switch blade engages with a twisting motion,

means for operating and imparting a twisting motion to said switch blade as it moves into and out of its circuit open and circuit closed positions with respect to said stationary terminal contact, a high voltage circuit breaker connected in series circuit with said switch blade having separable contacts enclosed in an arc extinguishing chamber, an operating mechanism for moving the separable contacts of said circuit breaker into and out of contact with each other, means responsive to said switch blade twisting means for controlling the operation of said operating mechanism in timed relation with the operations of said switch blade to respectively open and close the circuit through the separable contacts of said circuit breaker as the beaver-tail end of said switch blade is twisted into and out of contact with said stationary contact terminal, and a circuit breaker short circuiting blade connected to and extending from said switch blade operating means and movable into shunting relation with the separable contacts of said circuit breaker as the switch blade is twisted into its circuit closed position by said operating means and out of said shunting relation with respect to the contacts of said circuit breaker as said switch blade is twisted preparatory to a circuit disconnecting operation.

3. In an outdoor power line switching system, the combination of an air-break switch having an elongated circuit disconnecting blade mounted for both a pivotal and a twisting movement as it engages and disengages a cooperating stationary terminal contact at the end thereof, a linkage mechanism comprising a vertically extending shaft, a radially extending lever arm carried by said shaft and a forked-link connected to said lever arm normally extending over the operating axis of said shaft with its forked end connected to oppositely extending trunnions at the sides of said switch blade, whereby upon a circuit closing operation of said linkage mechanism said switch blade will be caused to first pivot about its pivotal axis from its open circuit position and be subsequently twisted into contact with said stationary terminal contact, an arc confining circuit breaker connected in series circuit with said switch blade, a line terminal for said circuit breaker having an auxiliary blade accommodating contact clip, and a shunt circuit forming blade connected to said switch blade adapted and arranged to move into engagement with said auxiliary blade accommodating contact clip and form a shunt circuit in parallel relation with the separable contacts of said circuit breaker as said switch blade is twisted into its final circuit closed position with respect to said stationary terminal contact, whereby said circuit breaker contacts will be shunt circuited by said auxiliary blade when the disconnecting switch blade is in its final circuit closed position.

4. In an outdoor power line switching system, the combination of an air-break disconnected switch having an elongated circuit disconnecting blade mounted for both a pivotal and a twisting movement as it engages and disengages a cooperating stationary terminal contact at the free end thereof, a linkage mechanism comprising an operating shaft, a radially extending lever arm carried by said shaft and a forked link connected at one end to said lever arm having its forked end connected to trunnions extending from opposite sides of said switch blade, whereby upon a circuit opening operation of said switch blade said linkage mechanism will cause said switch blade to first twist about its longitudinal axis and then pivot about its pivotal axis into an open circuit position, a circuit breaker connected in series circuit with said switch blade having separable contacts enclosed in an arc confining structure, a line terminal for said circuit breaker having an auxiliary blade accommodating contact clip, and an auxiliary shunt forming blade connected to said switch blade movable into shunt circuit forming engagement with said auxiliary blade accommodating contact clip as said switch blade is twisted into circuit establishing engagement with said stationary terminal contact, whereby a current carrying shunt circuit will be established through said auxiliary blade in parallel relation with the separable contacts of said circuit breaker when said switch blade is in its circuit closed position, said auxiliary blade being also movable out of engagement with said auxiliary contact clip by a reverse twisting of said switch blade prior to a pivotal circuit opening movement of said switch blade to thus render said circuit breaker operable independently of said shunting circuit for an arc free interruption of the power line current and a subsequent air gap isolation by the pivotal movement of said switch blade.

5. In an outdoor power line switching system, the combination of an air-break switch having an elongated circuit disconnecting blade mounted for both a pivotal circuit closing and a twisting movement for engagement with a cooperating stationary terminal contact at the outer end thereof, a linkage mechanism comprising an operating shaft, a radially extending lever arm upon said shaft and a forked link normally extending from said lever arm over the axis of said operating shaft and having its forked end connected to trunnions extending radially from the longitudinal axis of said switch blade, whereby upon a circuit opening operation of said linkage mechanism said switch blade will be first caused to twist about its longitudinal axis through a limited angle and then pivot upon its pivotal support into an open circuit position, a vacuum insulated circuit breaker connected in series circuit with said switch blade at its pivotally mounted end, a blade accommodating clip connected to the outer terminal of said circuit breaker disposed substantially in the plane of pivotal movement of said switch blade, and a shunt forming blade carried by and extending from said disconnecting switch blade and engaging said blade accommodating clip, said blade being movable out of circuit completing relation with said blade accommodating clip to thus place said circuit breaker in full series circuit relation with said disconnecting switch blade without said shunt forming blade when said switch blade is twisted about its axis preparatory to a circuit isolating operation thereof.

6. In an outdoor power line switching system, the combination of an air-break switch having an elongated circuit disconnecting blade mounted for both a pivotal circuit controlling and a twisting stationary terminal contact engaging and disengaging movement, an operating mechanism for imparting said pivotal and twisting movements to said switch blade, whereby upon a circuit opening operation of said operating mechanism said switch blade will be twisted about its longitudinal axis through a limited angle and then pivoted upon its pivotal support into an open circuit position, an arc interrupting circuit breaker connected in series circuit with said switch blade, a blade accommodating clip connected to the outer terminal of said circuit breaker, and a shunt forming blade connected to and mounted upon the pivotal end of said disconnecting switch blade engaging said blade accommodating clip and movable in a plane at a right angle to the plane in which said disconnecting switch blade operates and out of circuit completing relation with said blade accommodating clip to thus open the circuit formed by said shunt forming blade as said switch blade is twisted about its axis preparatory to a circuit isolating operation thereof.

7. In an outdoor power line switching system, the combination of an air-break switch having an elongated circuit disconnecting blade mounted for both a pivotal circuit controlling and a twisting stationary terminal contact engaging movement, an operating mechanism for imparting the pivotal and twisting movements to said switch blade, whereby upon a circuit closing operation of said operating mechanism said switch blade will be caused to twist about its longitudinal axis through a limited angle and then move upon its pivotal support from its open circuit position and finally twisted into engagement with said stationary terminal contact, an

arc interrupting circuit breaker connected in series circuit with said switch blade, an auxiliary blade accommodating clip connected to the outer terminal of said circuit breaker disposed substantially in the plane of pivotal movement of said switch blade, and a shunt forming blade connected to said disconnecting switch blade and engaging said blade accommodating clip, said shunt forming blade being movable into circuit completing relation with said blade accommodating clip as the disconnecting switch blade is twisted about its axis during the final circuit closing operation thereof to thus connect said shunt forming blade in parallel line current carrying relation with said circuit breaker.

8. In a high voltage circuit interrupting switch, the combination of a pivotally mounted disconnecting switch blade having a flattened beaver-tail end, a stationary terminal contact having opposed contact surfaces engageable by the beaver-tail end of said switch blade when twisted into right angled relation therebetween, means for operating said switch blade and imparting a twisting motion thereto as the beaver-tail end of said switch blade is pivotally moved into and out of engaging relation with said stationary terminal contact, a high voltage circuit breaker connected in series circuit with said switch blade having separable contacts operating in an arc suppressing medium, means for moving the separable contacts of said circuit breaker into and out of circuit establishing contact with each other, and a shunt circuit forming conductor carried by said switch blade movable in response to an operation of said means for imparting the pivotal and twisting motion to said switch blade, the operation of said shunt forming conductor being timed to provide a shunt circuit around the contacts of said circuit breaker as said switch blade is twisted into its final circuit closed position with respect to said stationary contact and to become inoperative as a shunt around the contacts of said circuit breaker during the initial twisting and circuit opening operation of said disconnecting switch blade.

9. In a power line load current disconnecting switch, the combination of an air-break circuit isolating switch having a pivotally mounted circuit disconnecting blade with a beaver-tail end that engages a stationary terminal contact with a twisting motion, a trip free arc extinguishing circuit breaker mounted adjacent the pivotal end of said switch blade and connected in series circuit between said switch blade and a line terminal, a switch blade operating mechanism for imparting a combined pivotal and twisting movement to said switch blade, a blade-like conductor connected to an extending at substantially a right angle to the longitudinal axis of said switch blade adapted and arranged to engage said contact clip and form a current shunting circuit around said circuit breaker when said switch blade is in its circuit closed position and to be moved out of circuit completing relation with said contact clip by a twisting operation of said switch blade prior to a pivotal power line circuit opening operation of said switch blade, and a circuit breaker tripping mechanism also controlled by said switch blade operating mechanism timed to trip said circuit breaker and open the circuit through said switch blade upon a twisting thereof and prior in point of time to an effective circuit interrupting pivotal movement of said switch blade.

10. In a power line load current disconnecting switch, the combination of an air-break circuit isolating switch having a pivotally mounted disconnecting switch blade with a beaver-tail end that engages a stationary contact terminal with a twisting motion, an arc extinguishing circuit breaker connected in series with said circuit switch blade and a line terminal, a contact clip carried by the line terminal of said circuit breaker, a switch blade operating mechanism for imparting a combined twisting and pivotal movement to said switch blade, a blade-like conductor connected to and extending at substantially a right angle to the longitudinal axis of said switch blade adapted and arranged to engage said contact clip and from a current shunting cricuit around said circuit breaker when said switch blade is in its circuit closed position and to be moved out of engagement with said contact clip during the initial twisting of said switch blade during a circuit opening operation thereof, whereby said shunt circuit will be opened and said circuit breaker contacts will be connected independently of said shunt circuit in series circuit when said switch blade is initially twisted for a circuit isolating operation, and a circuit breaker operating mechanism responsive to a blade twisting operation of said switch blade operating mechanism for effecting a power line circuit interrupting operation of said circuit breaker as the switch blade is twisted and prior in point of time to an effective circuit isolating pivotal movement of said switch blade.

11. In an outdoor power line switching system, the combination of an air-break switch having an elongated circuit isolating blade mounted for both a pivotal circuit opening and a twisting movement as it engages and disengages a cooperating stationary terminal contact at the outer end thereof, a linkage mechanism comprising an operating shaft, a radially extending lever arm upon said shaft and a forked-link extending from said lever arm with its forked end connected to trunnions extending radially from the twisting axis of said switch blade, whereby upon a circuit opening operation of said linkage mechanism said switch blade will be caused to first twist about its longitudinal axis through a limited angle and then pivot upon its pivotal support into an open circuit position, a vacuum insulated circuit breaker connected in series circuit with said switch blade, a blade accommodating clip connected with a line terminal of said circuit breaker disposed substantially in the plane of pivotal movement of said switch blade, and a shunt forming blade extending from said disconnecting switch blade normally engaging said blade accommodating clip, said shunt forming blade being movable in a plane at substantially a right angle to the plane in which said disconnecting switch blade operates and out of circuit establishing relation with said blade accommodating clip during the twisting operation of said switch blade, whereby said circuit breaker will be connected in series circuit with the disconnecting switch blade without the shunt circuit formed by said shunt circuit forming blade when said switch blade is operated to open the circuit.

12. In a high voltage circuit interrupting switch, the combination of a pivotally mounted disconnecting switch blade having a flattened beaver-tail end, a stationary terminal contact having opposed contact surfaces engageable by the beaver-tail end of said switch blade when twisted into right angled relation therebetween, means for operating said switch blade and imparting a twisting motion thereto as the beaver-tail end of said switch blade is pivotally moved into and out of engaging relation with said stationary terminal contact, a high voltage circuit breaker connected in series circuit with said switch blade having a power line terminal and separable contacts operating in an arc suppressing medium, spring means for moving the separable contacts of said circuit breaker into and out of circuit establishing contact with each other, and a shunt circuit forming conductor carried by said switch blade and movable into and out of contact with said circuit breaker line terminal and in response to the blade twisting operations of said means for imparting the pivotal and twisting motions to said switch blade, the operation of said shunt forming conductor being timed to form a shunt circuit around said circuit breaker as said switch blade is twisted into its final circuit closed position and to become inoperative as a shunt as the switch blade is twisted prior to the pivotal circuit opening operation of said switch blade.

13. In a high voltage arc free circuit interrupting and isolating switching means, the combination of a pivotally

mounted circuit disconnecting switch blade, a stationary line terminal contact engageable by said switch blade, means for operating said switch blade into and out of engaging relation with said stationary line terminal contact, a circuit breaker line terminal contact, a high voltage circuit breaker connected in series circuit between said switch blade and said circuit breaker line terminal contact having cooperating circuit interrupting contacts operating in an arc suppressing medium, means for moving the cooperating contacts of said circuit breaker into and out of circuit establishing engagement with each other, a shunt circuit forming conductor mounted at the pivotal end of said switch blade and engageable with said circuit breaker line terminal contact, and means for controlling the position of said shunt forming conductor with respect to said circuit breaker line terminal contact in timed relation with the circuit opening and closing movements of said switch blade with respect to said stationary terminal contact, whereby said shunt circuit forming conductor will be moved into engagement with said circuit breaker line terminal contact as said switch blade moves in its final closed circuit position and moved out of engagement with said circuit breaker line terminal contact upon an initial circuit opening operation of said switch blade.

14. In an outdoor power line switching system, the combination of an air-break switch having an elongated circuit isolating blade mounted for pivotal circuit opening and closing movements with respect to a stationary terminal contact at the outer end thereof, a vacuum insulated circuit breaker connected in series circuit with said switch blade, a line terminal for said circuit breaker having a blade accommodating clip disposed substantially in the plane of pivotal movement of said switch blade, and a shunt circuit forming blade extending from the pivotal end of said disconnecting switch blade normally engaging said blade accommodating clip, said shunt circuit forming blade being movable in a plane at substantially a right angle to the plane in which said disconnecting switch blade operates and out of circuit establishing relation with said blade accommodating clip during the initial circuit opening operation of said switch blade, whereby said circuit breaker will operate in full series circuit with said disconnecting switch blade when said switch blade is operated to open the circuit therethrough.

15. In a high voltage circuit interrupting switch, the combination of a pivotally mounted disconnecting switch blade, a stationary terminal contact having opposed contact surfaces engageable by the free end of said switch blade, means for operating said switch blade and imparting a pivotal movement into and out of engaging relation with said stationary terminal contact, a high voltage circuit breaker connected in series circuit with said switch blade having a power line terminal and separable contacts operating in an arc suppressing medium, means for moving the separable contacts of said circuit breaker into and out of circuit establishing contact with each other, and a shunt circuit forming conductor carried by said switch blade and movable into and out of contact with said circuit breaker line terminal, and means responsive to the means for imparting pivotal movement to said switch blade for moving said shunt circuit forming conductor in timed relation therewith to form a shunt circuit around said circuit breaker as said switch blade is moved into its final circuit closed position and to become inoperative as a shunt upon an initial circuit opening movement of said switch blade.

References Cited in the file of this patent

UNITED STATES PATENTS

2,480,622	Warnock	Aug. 30, 1949
2,601,138	Hart	June 17, 1952
2,697,153	Owens et al.	Dec. 14, 1954
2,769,063	Lingal	Oct. 30, 1956