March 17, 1931. A. O. AUSTIN 1,796,430

DISCONNECTING SWITCH

Filed March 9, 1928 4 Sheets-Sheet 1

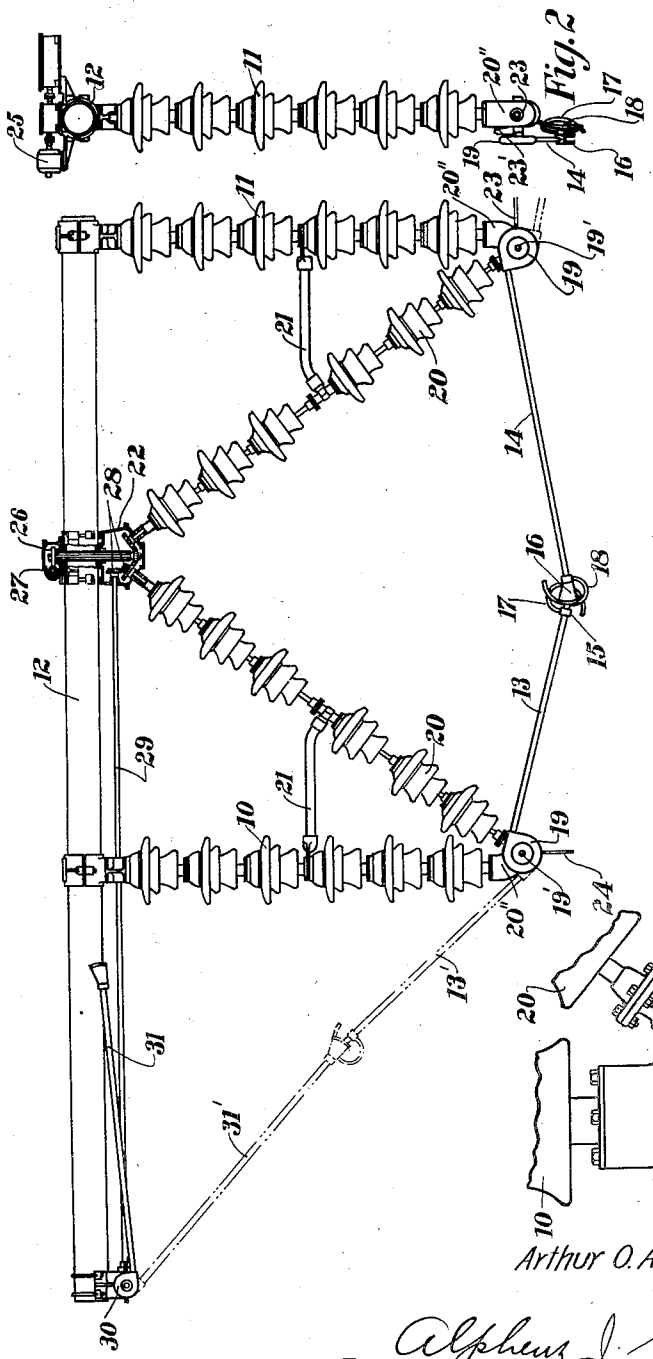


Fig. 1

Fig. 2

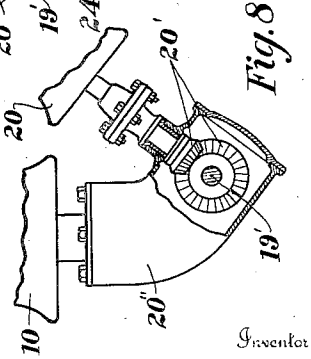


Fig. 8

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DISCONNECTING SWITCH

Filed March 9, 1928 4 Sheets-Sheet 2

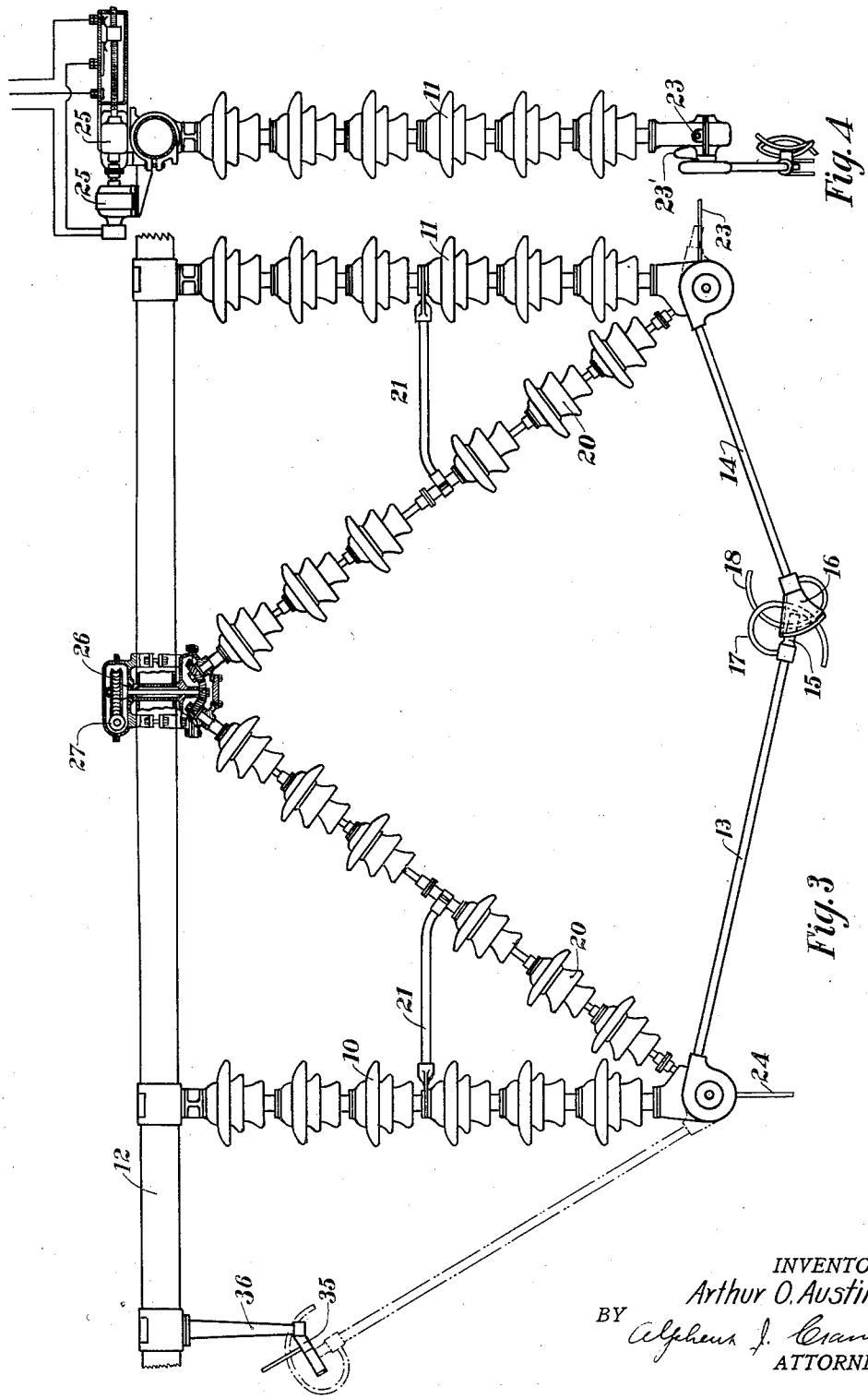


Fig. 4

Fig. 3

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DISCONNECTING SWITCH

Filed March 9, 1928 4 Sheets-Sheet 3

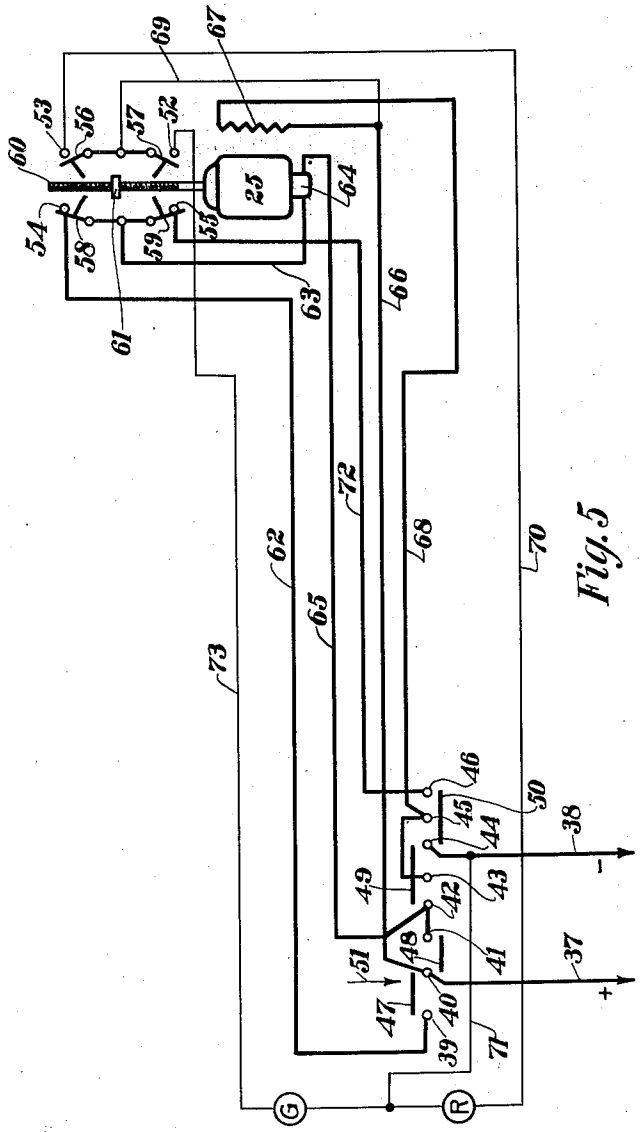


Fig. 5

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DISCONNECTING SWITCH

Filed March 9, 1928 4 Sheets-Sheet 4

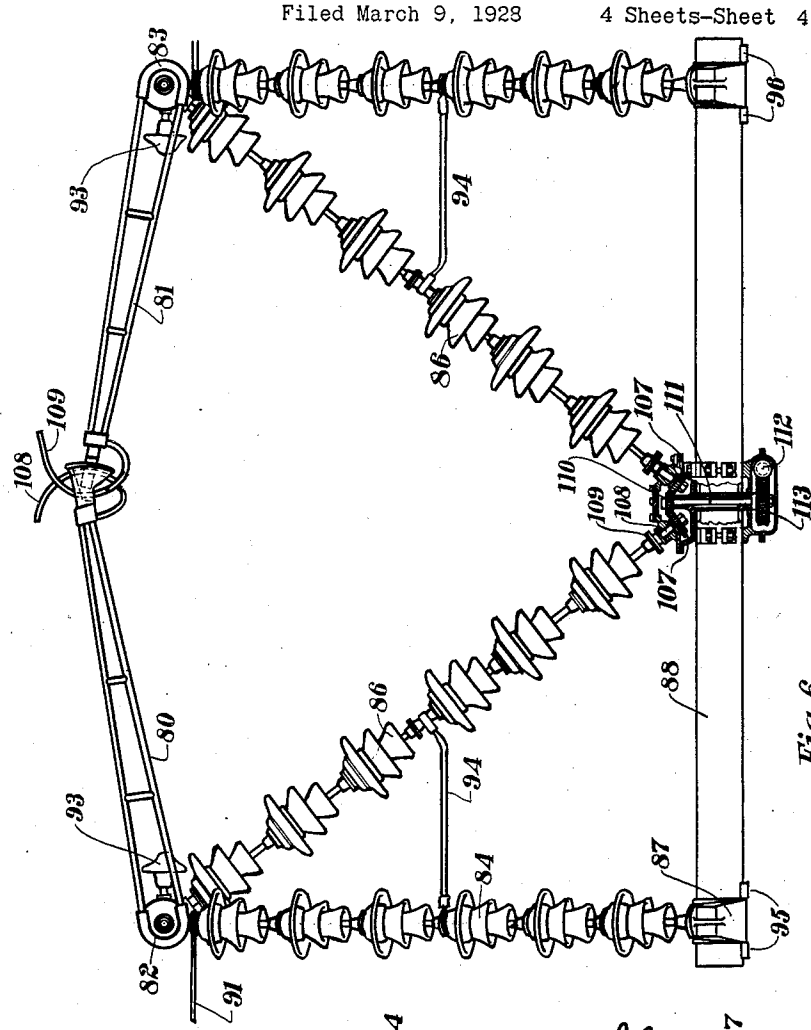


Fig. 6

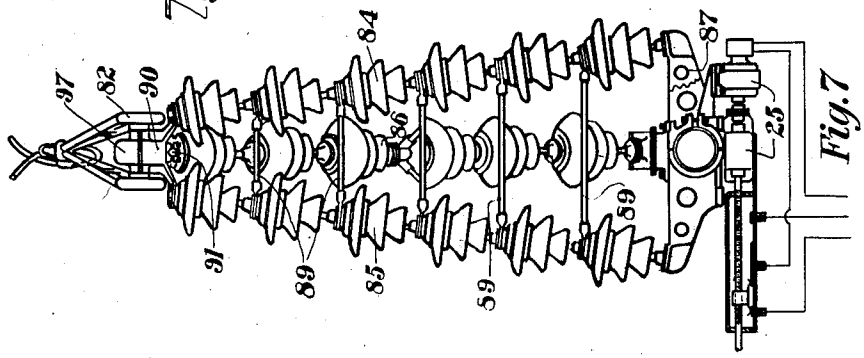


Fig. 7

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Patented Mar. 17, 1931

1,796,430

UNITED STATES PATENT OFFICE

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DISCONNECTING SWITCH

Application filed March 9, 1928. Serial No. 260,479.

This invention relates to disconnecting air break switches for high potential circuits. One object of the invention is to provide switches of the class named which may be highly insulated without seriously reducing the mechanical reliability of the parts. A further object is to provide a switch which is easily handled in operation, relatively low in cost and maintenance and which can be constructed for practically any current carrying capacity. A further object is to provide a switch that can be easily operated either by remote control or by hand and in which only very small torques are required for operating mechanism. Further objects and advantages will appear from the following description. The invention is exemplified in the combination and arrangement of parts shown in the accompanying drawing and described in the following specification, and it is more particularly pointed out in the appended claims.

In the drawings;

Fig. 1 is a side elevation of a disconnecting switch showing one embodiment of the present invention.

Fig. 2 is an end elevation of the switch shown in Fig. 1.

Fig. 3 is a view similar to Fig. 1, showing a slightly different form of the invention.

Fig. 4 is an end elevation of the switch shown in Fig. 3.

Fig. 5 is a wiring diagram of one form of remote control mechanism for operating the switch.

Fig. 6 is a side elevation of another modification of the invention.

Fig. 7 is an end elevation of the switch shown in Fig. 6.

Fig. 8 is a fragmentary elevation and section of a detail of construction.

In most high voltage transmission lines air break disconnecting switches are used to sectionalize the line or cut out different pieces of apparatus for making repairs or for other operating reasons. Where the voltages are exceedingly high, it is difficult to provide sufficient mechanical strength in the insulators for supporting the switch parts, and at the same time obtain sufficient insulation and contact for the carrying of current. Where disconnecting switches are used to cut out pieces of apparatus or for disconnecting sections of the line, the matter of safety is of great importance. This is particularly true where the insulation of the line is high and the connected system has large generating capacity. Under these conditions a power arc may strike from a switch terminal to a part which has been cut out of the circuit, thereby energizing it. Unless the part of the switch which has been taken out of the circuit has a very good ground connection, the voltage may rise on this part and endanger anyone working on the apparatus or destroy the apparatus itself.

With my improved type of switch, high insulation and large clearance are possible. At the same time, a construction is made possible which greatly facilitates the operation of the switch arms or blades forming the contact members and which also makes it possible to ground these arms.

In the disconnecting switch shown in Fig. 1, the switch is of the underhung type. The main insulator posts or stacks 10 and 11 are attached to a support 12. The insulator stacks 10 and 11 are provided with current carrying arms or blades 13 and 14 with contact members 15 and 16 and auxiliary contact members 17 and 18. These operating arms 13 and 14 are connected to heads 19 secured to shafts 19′, which are operated through rotating insulator stacks 20 and suitable gear mechanism 20′ in gear housing 20″. The insulator stacks 10 and 11 may be connected at various points to the stacks 20 by stiffening rods 21. As the insulator posts 20 together with the vertical posts 10 and 11 are attached at separated points to support 12 and come together at the operating heads 19, they form triangles with the support 12 and make a very stiff mechanical support. This arrangement takes advantage of the fact that the insulators will withstand a heavier force in tension and compression than they will if force is applied as a bending moment. The operating insulator stacks 20 not only perform the function of opening and closing the switch blades 13 and 14, but

also perform the function of braces, increasing the mechanical strength of the combination.

The operating insulator stacks 20 are moved through suitable gears located in the housing 22. In Fig. 1 the incoming line 23 makes contact through the flexible connector or pigtail 23; operating head 19 and arms 13 and 14 with the line 24 connected to the piece of apparatus or to the bus which it is desired to clear.

In operation the motor 25 drives a worm wheel 26 through a worm 27. The worm wheel is attached to a suitable spindle and gears for rotating the insulator stacks 20. Connected to one of the stacks 20 is a suitable pair of beveled gears 28 for the operation of the shaft 29. This shaft is geared to an operating head 30 connected with a switch arm 31 to be rotated through a suitable angle. The arm 31 is moved simultaneously with the switch arms or blades 13 and 14. While the relative movement of the several blades may be varied by changing the relative length of the arms or gear ratios, or other suitable means, the operation in general is as follows.

The arm 13 is made shorter than the arm 14 and the gear ratio driving the respective operating heads differs so that the arm will move to the position 13′ while the arm 14 moves through 180° or somewhat less. At the same time the arm 13 moves to the position of 13′, the ground arm 31 moves to the position 31′, making ground contact with the arm 13 and thoroughly grounding any apparatus attached to the lead 24. By properly proportioning the length of the arms and gear ratio, it is possible to make the blades 13 and 14 come into contact at the proper rate so that heavy contact pressure may be provided to insure low contact resistance and, at the same time, slight operating force will be necessary either to make or break the contact. If the two contact members come together at approximately the same circumferential velocity, the force exerted upon the arms 13 and 14 will be very largely in a longitudinal direction in which direction the supporting insulators offer considerable resistance.

It is evident that if the length of the arm 14 compared to the length of the arm 13 is inversely proportional to the angular velocity of the respective arms, the contact members will have approximately the same velocity in a tangential direction upon coming together, thus making it possible to provide heavy contact pressures without placing heavy working stresses upon the insulator or upon the operating mechanism. The sliding and twisting motion of the contacts insures a good electrical contact surface and the auxiliary contact members 17 and 18 prevent burning or pitting of the main contact members as they carry the current upon making or breaking the connections in closing or opening the switch. The arrangement makes it possible to provide adequate insulation and clearance and, at the same time, sufficient contact and current carrying parts together with ground, where grounding is desired. As the ground arm 31 is provided with operating mechanism, it may be rotated into the position shown in full lines when the switch is closed, so that it will not cut out the insulation or clearance of the disconnecting switch. With this arrangement it is possible to use rather short contact arms 13 and 14 which are much shorter than the insulator stacks 10 or clearance to the ground and, at the same time, provide a sufficient connection when the switch is open.

The form of the invention shown in Figs. 3 and 4 is similar to that shown in Figs. 1 and 2 except that the ground connection is provided with a stationary contact 35 instead of a movable contact arm as shown in Fig. 1. The stationary contact 35 is carried by a post or rigid arm 36 fastened to the support 12. Where a stationary ground contact is used the switch arm 13 should preferably be longer than is required where a movable grounding contact is used in order that the contact may be sufficiently spaced from the conductor when the switch is closed so that the flashover voltage of the insulator will not be materially reduced.

The motor 25 for opening and closing the switch may be provided with suitable remote control mechanism so that the switch may be operated by a control button located at any convenient position. One form of connection for such control is shown Fig. 5. The current for the motor is supplied from a D. C. source having a positive lead 37 and a negative lead 38. A control switch is provided with contacts 39, 40, 41, 42, 43, 44, 45 and 46 and with blades 47, 48, 49 and 50. The blades are all mounted on a single support and are spring held in the open position shown in Fig. 5. The motor 25 is provided with an automatic limit switch comprising contacts 52, 53, 54 and 55 and switch blades 56, 57, 58 and 59. A threaded shaft 60 is driven by the motor and operates a runner 61 which engages the blades of the limit switch at the opposite ends of its travel.

In order to close the line switch the control switch is moved in the direction of the arrow 51. This connects the contacts 39 and 40 and energizes the conductor 62 so that current flows through the contact 54 and blade 58 to the conductor 63 and commutator 64 of the motor 25. The return circuit is through the conductor 65, contact 42, blade 49 and conductor 44 to the negative terminal 38. The field circuit for the motor is through the conductor 66, field coil 67, conductor 68, terminal 43, switch

blade 49 and contact 44 to the negative lead 38. When this connection is made the motor 25 is driven in the direction to close the line switch. This will cause the runner 61 to move away from the motor 25 until it engages the blades 58 and 56 and opens the blade 58 and closes the blade 56. When the blade 58 is opened the circuit to the motor through the conductors 62 and 63 will be broken and the motor will stop. At the same time current will flow through the conductors 66, 69, 70 and 71 and illuminate a red light R. The parts will remain in this condition after the control switch is released, for the light circuit depends entirely on the switch blade 56 and is not changed by the control switch. If the switch again be moved in the direction of the arrow 51, no effect will be produced on the motor as the switch blade 58 will continue to be held open by the runner 61.

When it is desired to open the line switch the control switch is moved in the direction opposite to that indicated by arrow 51. Current will then flow to the field winding through the conductor 66 and return through the conductor 68, contact 45, blade 55 and contact 44 to the negative lead 38. It is noted that for both closed positions of the control switch, current flows through the field winding of the motor in the same direction. One terminal of the field winding is continuously connected with the positive lead. When the control switch is closed in a direction opposite to arrow 51, current will flow to the armature through contacts 40 and 41, blade 48, conductor 65 and will return through conductor 63, blade 59, contact 55, conductor 72, contact 46, blade 50 and contact 44. This supplies current to the armature in the reverse direction and causes the motor to operate in the direction to open the line switch. The runner 61 will move away from the blade 58 and 56 and permit the blade 58 to close the blade 56 to open. When the blade 56 opens the red light R. will be put out. When the motor has operated a sufficient amount to move the line switch to its extreme open position and ground the disconnecting portion, the runner 61 will engage the blades 57 and 59 opening the blade 59 and closing the blade 57. This will open the armature circuit and stop the motor and at the same time will close the circuit 57 and illuminate the green light G. through conductors 69, 73 and 71. The green light will remain illuminated until the conductor switch is again moved in the direction to operate the motor and close the line switch. It will only be necessary for the operator to move the control switch in one direction or the other and the motor will then operate the line switch either to open or close the same, and the signal lights R. and G. will indicate the position of the line switch.

In the modification shown in Figs. 6 and 7, the switch arms 80 and 81 are attached to the pivotally mounted operating heads 82 and 83. These operating heads are each supported by insulator columns 84, 85 and 86. The transverse insulator columns 84 and 85 are mounted on a cross bracket, 87, which in turn is fastened to a supporting switch base 88. The embodiment shown in the switch base is formed of a large tubular member in order to afford strength and rigidity with minimum size and weight. The insulator stacks 84 and 85 are inclined inwardly toward the operating head and are well spread at the base where they are attached to bracket 87, thus forming a well braced structure. The strength of the structure is further increased by cross braces 89 and support 90 for the operating head 82. Part or all of the braces 89 may be omitted in some cases, the number of braces used depending upon the character of the insulators in the stacks and the mechanical strength required. The incoming bus bar or conductor 91, is attached to the support 20 for the operating heads and applies a mechanical load to the upper end of the insulator stacks. The load applied by the conductor 91 may be an appreciable addition to the stress set up by the operation of the switch blades and it is necessary for the supporting insulator columns to have sufficient strength to withstand these stresses. The inclined position of the columns 84 and 85 affords large mechanical strength in a transverse direction but has only the combined bending moment of the two insulator columns in the direction of the plane of the switch, and it is therefore necessary to provide mechanical strength in this direction. This is accomplished very easily by the operating insulated columns 86. These insulated columns while free to rotate to operate the switch arms through gear mechanism in the supports 90, are rigid columns and are connected at the opposite ends so that they can be used to withstand either tension or compression, thereby affording considerable strength to the insulator stack in the longitudinal direction of the switch. The disposition of the insulators and interposed metal fittings in the various columns, tends to improve the electrostatic field because of the capacity of the supporting columns. This tends to prevent concentration of the electrostatic stresses on the switch parts which is of particular advantage when the switch members are opened. The electrostatic field may be further improved by the use of insulated controls shown at 93 and more completely described in my prior Patent No. 1,521,743 granted January 6, 1925.

In order to stiffen the operating insulator stack 86, it is attached to the main column insulator 84 and 85 through suitable struts 94. These struts should join equipotential points in the respective stacks insofar as this is possible. The switch base or supporting member 88 is usually supported at two points such as 95 and 96, which are bolted to a structural steel bus support, not shown.

The operating heads 82 and 83 are fixed to shafts extending through the gear housing 97 on the members 90 and driven by suitable gearing operating by the columns or stacks 86.

The lower ends of the operating insulator stacks 86 are shown in detail in Fig. 6. A suitable beveled gear 107 is attached to a shaft 108 and a flange 109, the flange 109 being attached to the base of the insulator stack 86. The gear 107 is placed preferably at one side of the center line so that there will be room for an operating pinion 110 which will mesh with it. This operating pinion is mounted on a shaft 111 which in turn is driven by a worm and wheel combination 112 and 113 or other suitable mechanism. The construction is such that the gears may be totally enclosed so that they will be protected from sleet and rain and the pockets are constructed so that they will contain oil so that all parts will be lubricated when operated. It will be seen that the rotation of the worm 112 will drive the wheel 113 which in turn drives the beveled gears 107, connected to insulator assemblies 86. It will be seen that both switch members 80 and 81 will be operated simultaneously. The worm 112 can be connected to a driving motor 25, operated in the manner previously described.

The member 80 is made slightly longer than 81 and has a pocket or slot with the opening facing downward. The lower side and end into which the contact member of 81 enters is flared so that the members will mesh even though they are not exactly in alinement. Horns or auxiliary contact members 108 and 109 are attached to the operating members 80 and 81 respectively. These auxiliary contact members form the initial contact as the blades come together or break the arc as the switch blades part. As the contact members have projecting parts which tend to lower the flashover voltage by the concentration of electrostatic flux, the contact and final resting place of the switch in closed position is preferably above the line joining the switch pivots for this provides greater clearance between the switch contacts and the grounded support and places the projections on the lower side of the contacts, which tend to discharge to ground, in a field of less concentration than they would occupy if the switch arms were permitted to swing farther down.

It is evident that the construction of the switch is such that the blades may be stopped in practically any position desired by the proper adjustment of parts and the switch can be so constructed that suitable contact will be made over an appreciable arc without any change in the adjustment. In opening or closing, the switch has a slight twisting motion on the contact blades which will readily break corrosion or sleet and will permit of heavy contact pressures without producing large operating forces in the switch itself. If one arm is longer than the other and the arms rotate at the same angular speed or if the longer arm rotates at the greater angular speed as shown in Fig. 3, there will also be a relative vertical sliding motion between the contact surfaces in addition to the rotational and withdrawing movement. In some cases this may have an advantage as the main contact members will be in contact over a much shorter period of time and any difference in distortion of the operating mechanism or parts may be readily compensated for. When the main contact surface is equi-distance from the two operating heads, the force on the switch would be at a minimum in opening or closing. The torsional force will exert but very small force upon the insulator stack. A very appreciable longitudinal force may be compensated by the stress taken up in the operating insulator stacks 86 which are placed at an angle.

I claim:—

1. A switch for a high potential conductor comprising an insulating column, a switch arm supported by said column, an insulating brace disposed at an angle to said column and a driving connection between said brace and switch arm to operate said arm from said brace.

2. A switch comprising a supporting column, a switch arm carried by said column and a shaft for operating said switch arm arranged at an angle to said column and serving as a brace for said column.

3. A switch comprising an upright column formed of a plurality of insulator units, a switch arm carried by said column and a shaft for operating said switch arm comprising a plurality of connected insulator units said shaft being arranged at an angle to said column and serving as a brace for said column.

4. A switch comprising an upright column formed of a plurality of insulator units, a gear housing supported by said column, a switch arm carried by said housing, a shaft for driving said switch arm connected with said housing and extending therefrom at an angle to said column substantially in the plane of said switch arm and means for driving said shaft to operate said switch arm, said shaft being formed of a plurality of

connected insulator units and serving also as a brace for said column.

5. A switch comprising a support, a pair of columns mounted on said support in spaced relation to each other, said columns each being formed of a plurality of insulator units, a switch arm carried by each of said columns and arranged to swing into and out of contact with each other and a bracing shaft disposed at an angle to each of said columns and connected with said support and arranged to operate said switch arms respectively, said bracing shafts being formed of a plurality of insulators connected together.

6. A disconnecting switch comprising a supporting base, insulating columns mounted on said base in spaced relation to each other, switch arms carried by said columns and movable into and out of contact with each other, conductors supported by said columns and electrically connected with said switch arms respectively, shafts connected with said columns respectively and with said base and inclined relative to said columns and disposed in the plane of said switch arms to serve as bracing members for said columns and means for driving said shafts for operating said switch arms.

7. A switch for high potential conductors comprising a plurality of supporting columns each formed of separate insulator units connected by metallic fittings, a switch arm bearing mounted on adjacent ends of said columns and securing said ends together, a switch arm pivotally mounted on said bearing, and a bracing member connecting said columns between the ends thereof, said bracing member being attached to said columns at substantially equi-potential positions on said columns.

8. A switch for high potential conductors comprising a supporting column formed of a plurality of insulator units, metallic fittings rigidly connecting said units in series, a switch arm pivotally mounted on said column, gearing carried by said column for operating said switch arm, a shaft having one end connected with said column and arranged to operate said gearing, said shaft being formed of a plurality of insulator units rigidly connected by interposed metallic fittings and extending in the plane of said switch arm at an angle to said column and a bracing bar connecting said column and shaft at substantially equi-potential positions thereon.

9. A switch for high potential conductors comprising a support, insulator columns mounted on said support in spaced relation to each other, a switch arm carried by each of said columns and movable into and out of engagement with each other, a gear housing mounted on said base between said columns, insulator shafts extending at an angle from said gear housing to said columns and operatively connected with said switch arms respectively to move said switch arms, gearing disposed in said gear housing for driving said shafts and a drive for said gearing.

10. A disconnecting switch comprising a pair of spaced insulator columns, switch arms pivotally mounted on said columns and arranged to engage each other at their free ends and to exert a force on the contacting portions of said arms, substantially in the direction of the length of said arms and transversely of said columns, and inclined insulator bracing members for said columns, said bracing members being arranged to drive said switch arms to open and close the same.

11. A disconnecting switch comprising an insulating support having one terminal of said switch mounted thereon and a grounding connection for said terminal, said grounding connection being movable towards said terminal for effecting grounding thereof, when said switch is open and movable away from said terminal when said switch is closed.

12. A disconnecting switch comprising a pair of spaced insulator columns, switch arms pivotally mounted on said columns respectively, said switch arms extending between said columns and arranged to meet for end contact, inclined insulating braces disposed between said columns substantially in the plane of said columns and switch arms and means for rotating said braces to operate said switch arms.

13. In combination an insulator support, a switch arm pivotally mounted on said support, a live terminal member arranged to be engaged by said switch arm when said switch arm is closed, a grounding terminal arranged to be engaged by said switch arm when said switch arm is open, and driving mechanism arranged to open said switch arm and move said grounded terminal into position to engage said switch arm when said switch arm is opened and to move said grounded terminal away from the portion of said insulating support, upon which said switch arm is mounted when said switch arm is closed.

14. A disconnecting switch comprising a switch arm, an operating head for said switch arm, a pair of insulating holding members disposed at an angle to each other and connected with said operating head and a driving connection between one of said holding members and said switch arm for operating said switch arm.

15. In combination a pair of spaced insulating supports, cooperating switch arms carried by said supports respectively and arranged to contact at their end between said supports, one of said arms being longer than the other, and means for driving said switch

arms at different angular speeds to impart substantially equal linear speed to the contacting portion of said switch arms.

16. A disconnecting switch comprising a switch arm, and a member for grounding said switch arm when said arm is open, said member being movable away from said switch to provide unimpaired clearance when said switch is closed.

17. A disconnecting switch comprising a terminal for connection with a live conductor, a second terminal connected by said switch with said first terminal when said switch is closed and disconnected therefrom when said switch is open, an insulating support for said second terminal, and a grounding member for said second terminal, said grounding member being movable to an inoperative position when said switch is closed to provide unimpaired clearance for said terminals.

18. A disconnecting switch comprising a switch arm, a mounting for said switch arm, said switch arm being shorter than the distance from said mounting to the nearest grounded conductor when said switch is closed, and a grounded member movable into position to engage said switch arm when said switch is open.

In testimony whereof I have signed my name to this specification this 6th day of March, A. D. 1928.

ARTHUR O. AUSTIN.