April 8, 1958 T. A. FJELLSTEDT 2,830,144

DISCONNECTING SWITCH

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Fig. 1

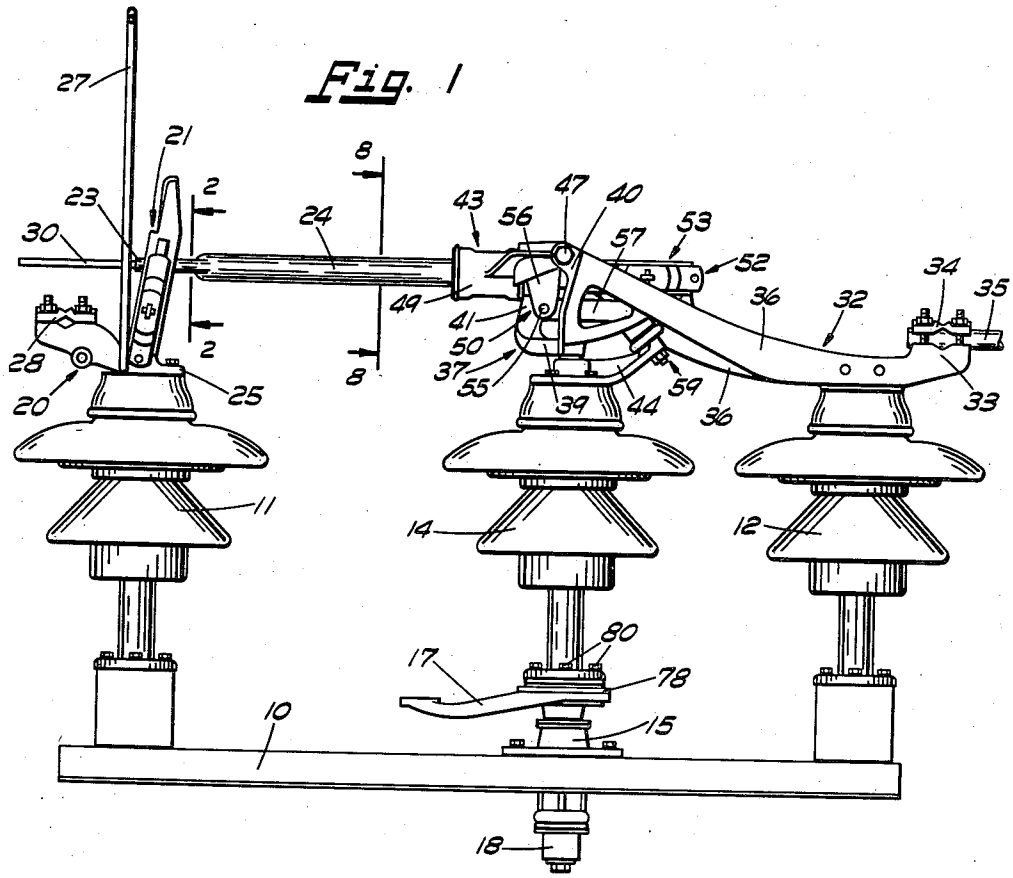


Fig. 2

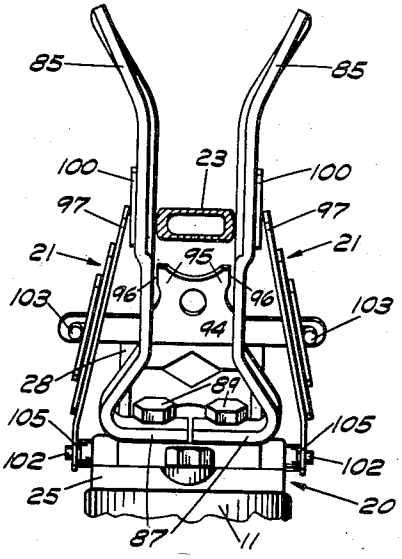
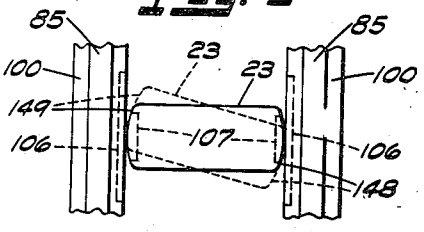


Fig. 3



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April 8, 1958 T. A. FJELLSTEDT 2,830,144

DISCONNECTING SWITCH

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Fig. 4

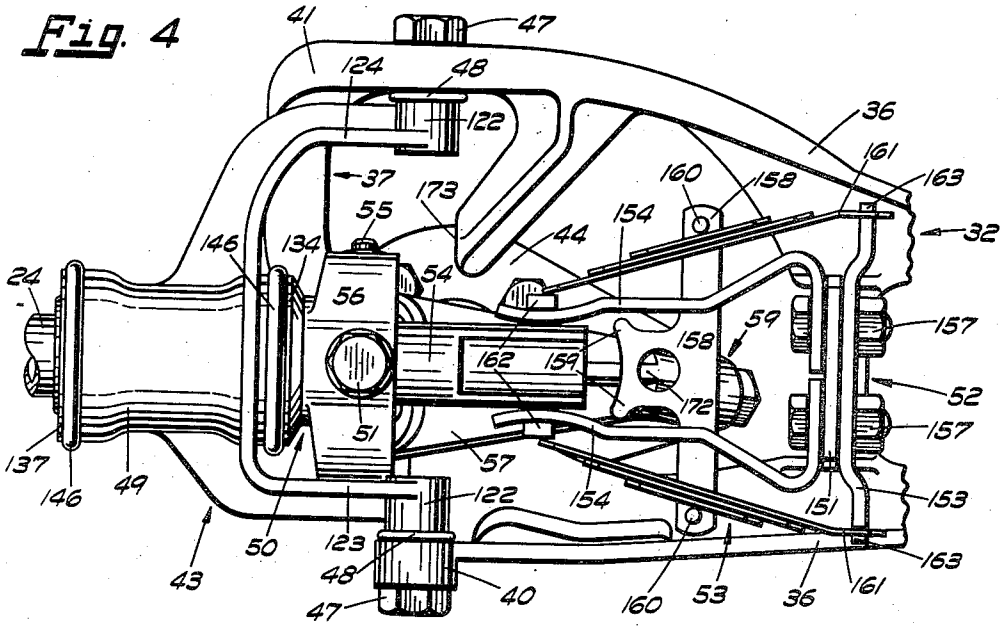
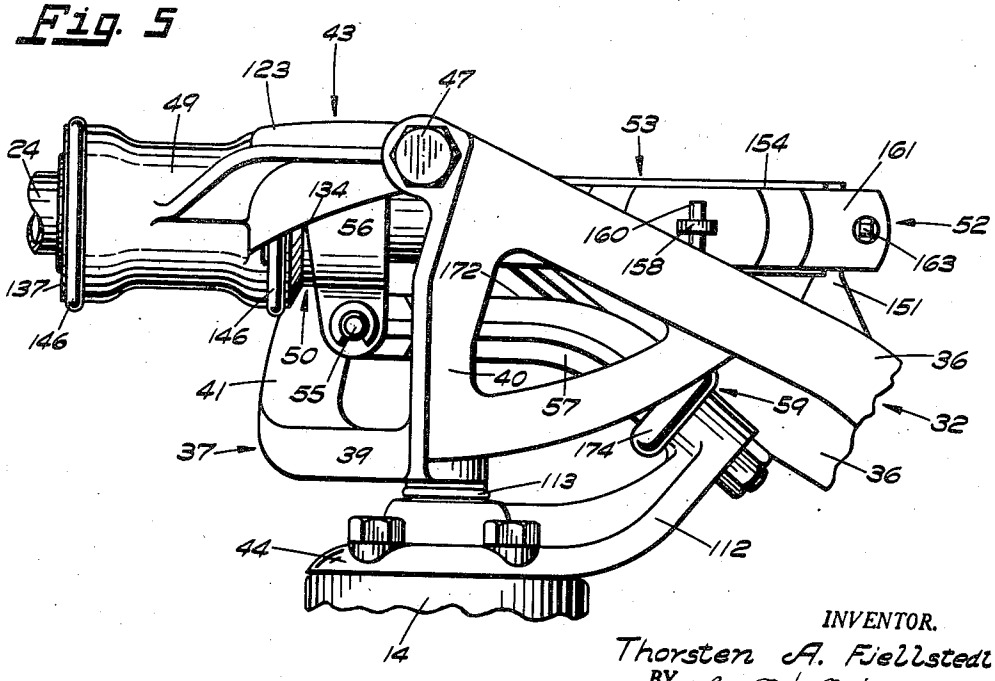


Fig. 5



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April 8, 1958 T. A. FJELLSTEDT 2,830,144

DISCONNECTING SWITCH

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Fig. 6

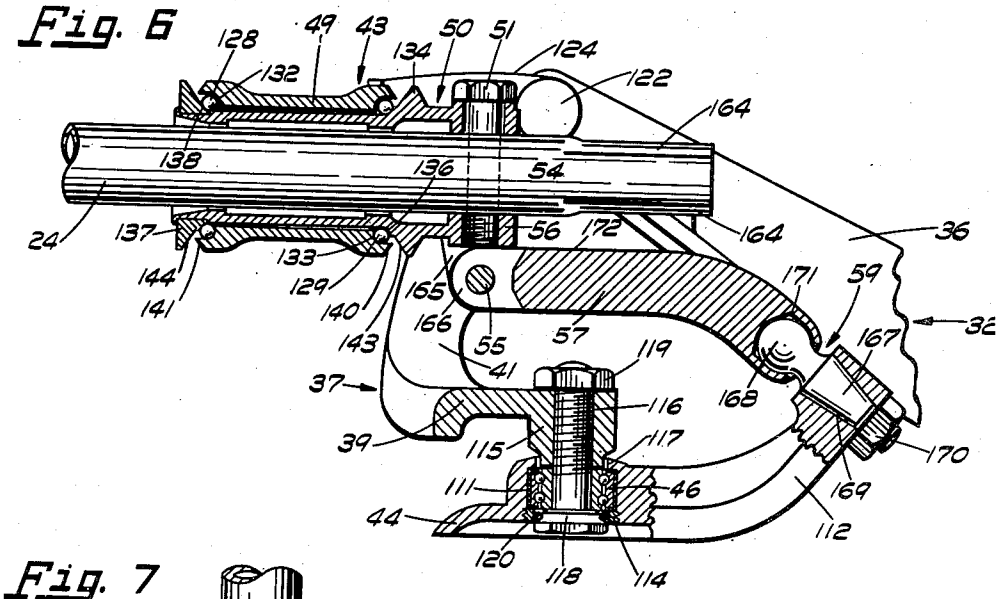
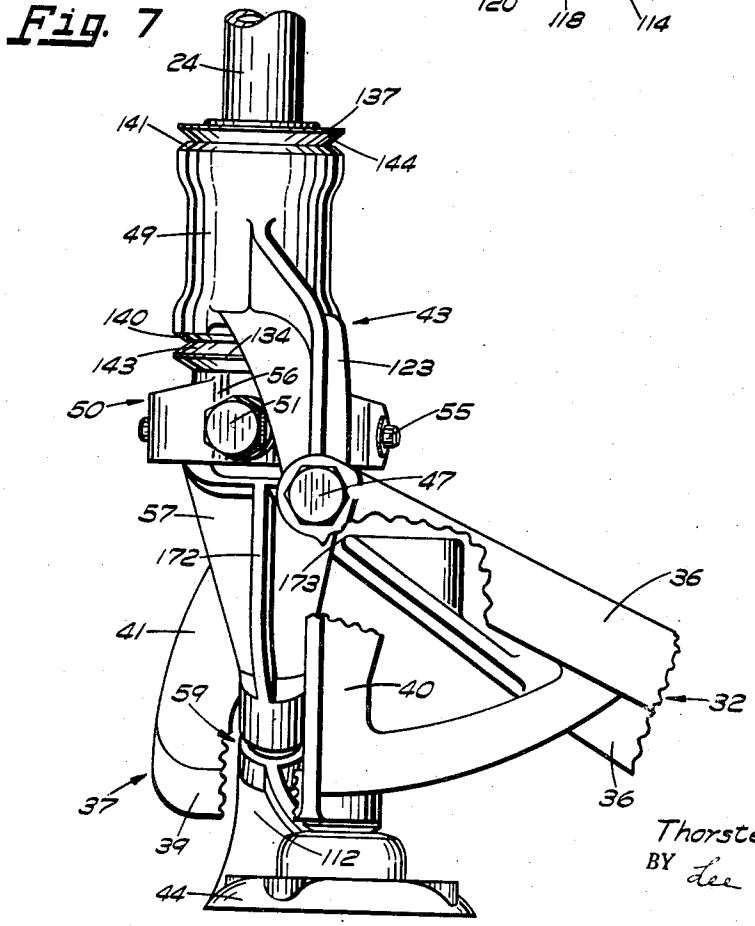


Fig. 7



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April 8, 1958 T. A. FJELLSTEDT 2,830,144

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Fig. 8

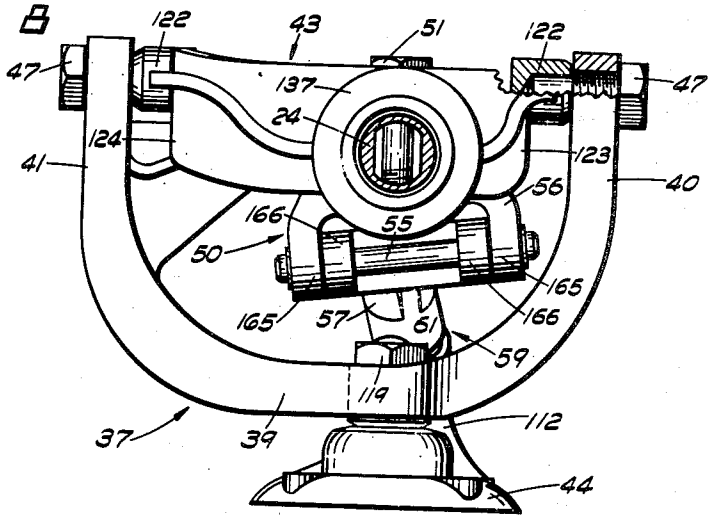
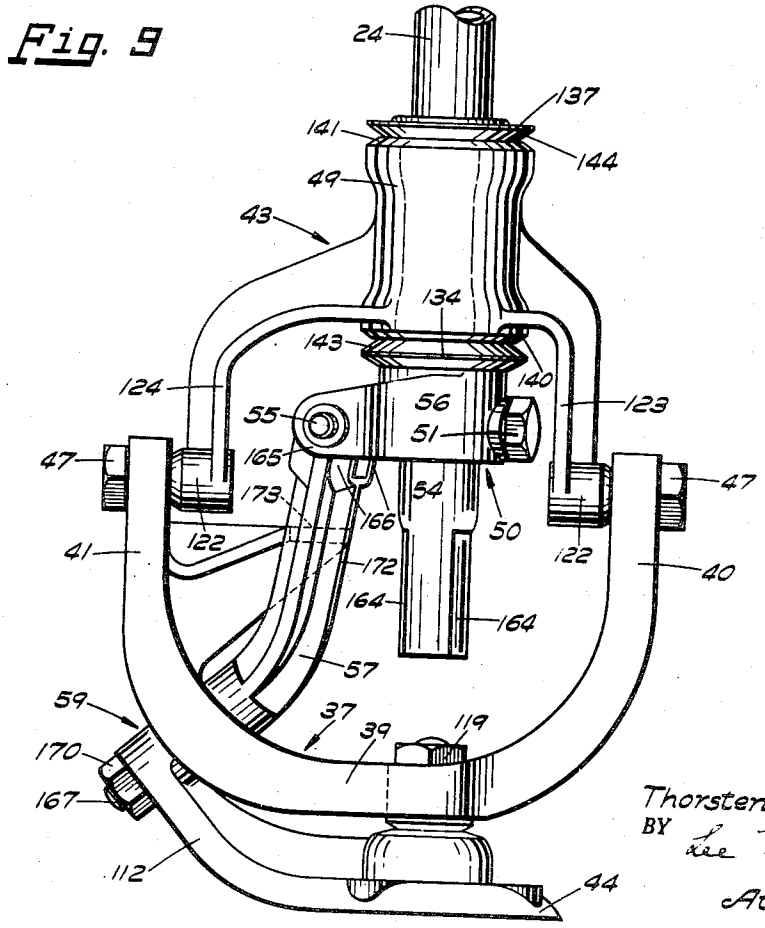


Fig. 9



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DISCONNECTING SWITCH

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Fig. 10

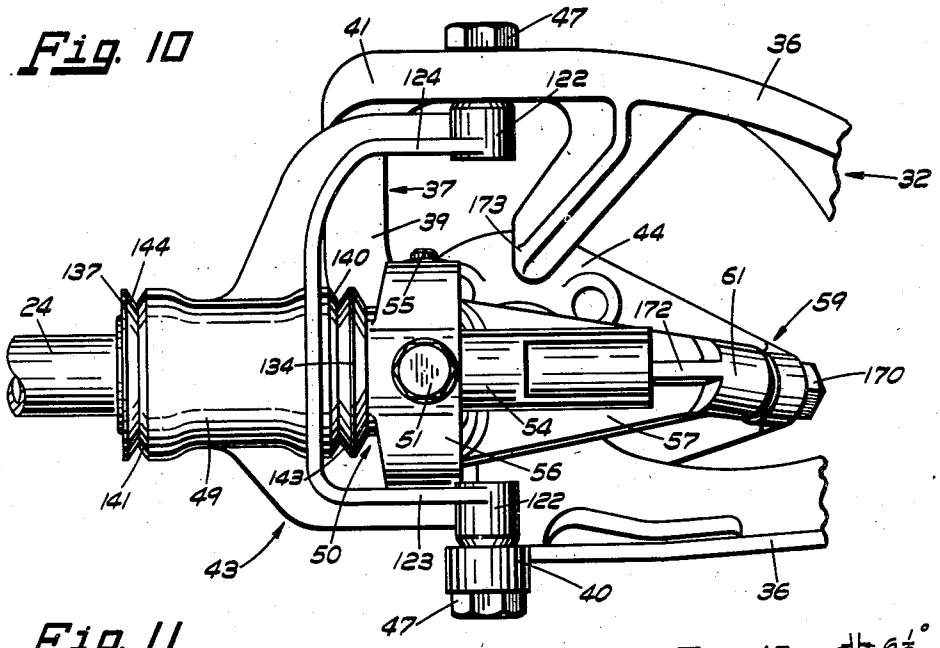


Fig. 11

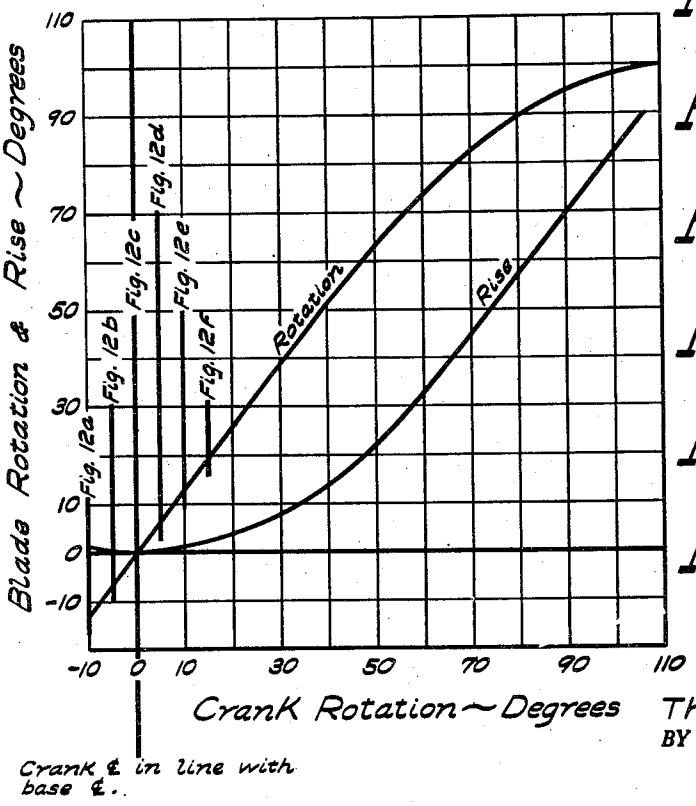


Fig. 12a

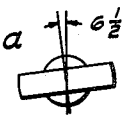


Fig. 12b

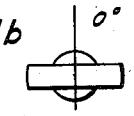


Fig. 12c

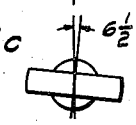


Fig. 12d

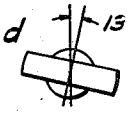


Fig. 12e

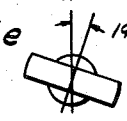
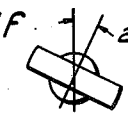


Fig. 12f



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United States Patent Office 2,830,144 Patented Apr. 8, 1958

2,830,144

DISCONNECTING SWITCH

Thorsten A. Fjellstedt, Ingleside, Ill., assignor to McGraw-Edison Company, a corporation of Delaware

Application August 11, 1954, Serial No. 449,129

14 Claims. (Cl. 200—48)

This invention relates to electric switches and more particular to disconnecting switches of the type in which the switch blade is adapted to be swung into and out of cooperating relation with stationary contacts and to be rotated about its longitudinal axis to bring oppositely disposed contact surfaces into high pressure engagement with the stationary contacts.

In the art to which the present invention relates there are several types of operating mechanisms for disconnecting switches adapted to swing the switch blade between open and closed position and also to rotate the blade to bring the ends thereof into high pressure engagement with stationary contacts. In one type of disconnecting switch the operating mechanism does not support the blade throughout the entire movement of the rotatable insulator and a stop must be provided to limit the downward travel of the blade within the stationary contact. In opening a switch of this type, the blade would normally move downward when its rotation begins, but inasmuch as the stop prevents the blade from dropping, undue strain is placed on the blade actuating mechanism. A major portion of the force available for operating the blade is expended during initial rotation of the insulator in preventing swinging movement of the blade and only a minor portion is available for blade rotation. That is the major portion of the power for operating the blade which should be effective in producing blade rotation is lost in strains produced by the stop. Thus the operating effort is unnecessarily high in opening the switch blade, maintenance difficulties are increased, and switch life is correspondingly reduced. In other types of switches wherein the blade is wholly supported by the actuating mechanism, the force available for operating the blade is substantially equally divided between blade rotation and blade rise. As a consequence, the high contact pressure between blade and stationary contact is not fully relieved in this type of switch before blade rise is initiated, and unnecessarily high mechanical force, i. e., operating effort, is required to open the switch blade. Conversely, this type of mechanism does not always allow the switch blade to enter the stationary contacts before initial contact pressure is applied.

In both types of switch maximum contact pressure is only obtained if the blade is in perfect alignment with the contact shoes, and any undertravel or overtravel of the switch blade into the stationary contacts results in contact pressure less than the maximum obtainable. The many levers and links of such prior art switches provide an operating action with high spots and stops and does not result in smooth operation. Certain prior art disconnect switches have too many contact interchange surfaces, thus raising the voltage drop across the switch and causing unnecessary heating, whereas in other prior art switches this high voltage drop is only eliminated by the use of flexible leads to connect relatively movable parts of the switch.

It is one object of the invention to provide an operating mechanism which furnishes smooth, positive operation for swinging and rotating a switch blade without high spots or stops in the operating action.

It is a further object of the invention to provide an operating mechanism for a disconnecting switch wherein a minimum of operating effort imparts a powerful mechanical advantage to rotate the blade prior to rise from the contacts, thus providing positive contact break under adverse conditions such as ice and corrosion.

It is a still further object of the invention to provide an operating mechanism for a disconnecting switch which does not require a stop to prevent dropping of the blade during initial blade rotation as in certain prior art switches. It will be appreciated that the elimination of the stop decreases the operating effort and greatly increases switch life in comparison to prior art switches wherein forcing the blade against the stop during the initial movement of the rotatable insulator placed undue strain on the operating mechanism.

It is an object of the invention to provide a blade operating mechanism wherein substantially all of the force available for operating the blade is translated into blade rotation during the initial rotation of the insulator and is increasingly transferred to blade rise with continued crank rotation after the blade has broken free of the stationary contact jaw.

A still further object is to provide an actuating mechanism which permits the blade to fully enter the contacts before initial contact pressure is applied.

Still another object of the invention is to provide a disconnect switch wherein maximum contact pressure is obtained regardless of the amount of undertravel or overtravel of the blade into the contacts.

Still another object of the invention is to provide a disconnect switch having a minimum number of current interchange surfaces and which does not require flexible leads, as used between relatively movable parts in prior art switches to lower the voltage drop across the switch.

Still another object is to provide a disconnect switch wherein the stationary contact jaws are preloaded prior to entrance of the blade and enable the twisting motion of the blade to establish full contact pressure with practically no movement of the contact shoes. It will be appreciated that operating effort is minimized when establishing full contact pressure with such preloaded contact shoes, thereby greatly reducing the strain on the parts and improving switch life and maintenance.

A still further object of the invention is to provide a disconnect switch wherein all bearings and joints are shielded by novel sealing means which prevent entrance of foreign matter such as water into the bearing race which might freeze or start corrosion.

A further object of the invention is to provide sealing means which cause any ice accumulated over the bearing to be subjected to cantilever stress when the switch operates. It will be appreciated that ice in this condition is weakest and that strain on the parts is thus minimized when ice breaking is necessary to permit free operation of the switch.

A further object is to provide novel bearing seals for a disconnect switch whose physical characteristics are not changed in temperature ranges fom minus 100 degrees F. to 300 degrees F. and whose life is not affected by sunlight, acids, or corrosive or salt atmospheres.

Further objects and advantages of the invention will be apparent upon consideration of the following detailed description of a preferred embodiment thereof, when taken in connection with the attached drawing wherein:

Fig. 1 is a side view of a preferred embodiment of the disconnect switch of the present invention in closed position;

Fig. 2 is a vertical sectional view taken on line 2—2 of Fig. 1 and showing the free end of the switch blade in high pressure engagement with the stationary contact;

Fig. 3 is an enlarged end view of the switch blade illustrating the manner in which constant contact pressure is maintained with the stationary contact regardless of undertravel or overtravel of the blade;

Fig. 4 is an enlarged fragmentary top view of the switch illustrating the blade operating mechanism of the embodiment of Fig. 1;

Fig. 5 is an enlarged fragmentary side elevation view of the switch illustrating the blade operating mechanism of the embodiment of Fig. 1;

Fig. 6 is an enlarged fragmentary side view of the switch taken on the longitudinal axis of the blade and showing the blade operating mechanism of the embodiment of Fig. 1;

Fig. 7 is an enlarged fragmentary side view of the switch illustrating the blade operating mechanism of the embodiment of Fig. 1 with the switch blade in open position and with the frame support partially broken away;

Fig. 8 is an enlarged fragmentary view, partly in section, taken on line 8—8 of Fig. 1 showing the blade operating mechanism in closed position;

Fig. 9 is a view similar to Fig. 8 showing the switch blade and operating mechanism in open position;

Fig. 10 is a view similar to Fig. 4 with parts removed to better illustrate the blade operating mechanism;

Fig. 11 is a set of blade motion curves plotting blade rotation and blade rise of the embodiment of Fig. 1 versus degree of crank rotation; and

Figs. 12*a* to 12*f* are front views of the beavertail portion of the switch blade and illustrate the rotation of the switch blade about its longitudinal axis for various positions of crank rotation shown in Fig. 11.

The overall construction and operation of the disconnect switch of the invention will be briefly described with particular reference to Fig. 1 before the cooperating parts are discussed in detail. A rotating insulator, vertical break air switch is mounted on a horizontal channel, or base, **10** which supports spaced apart, vertical stationary insulators **11** and **12** and a rotatable insulator **14** in alignment with and disposed between the stationary insulators **11** and **12**. The insulator **11**, **12**, and **14** are of conventional construction and are illustrated as of the pin type. A bearing housing **15** extending through and secured to the base **10** encloses a main ball bearing (not shown) which supports the rotatable insulator **14** and allows it to rotate about its own axis in operating the switch. In the preferred embodiment of the invention shown in Fig. 1 the axis of rotatable insulator **14** is in a vertical plane.

The rotatable insulator **14** can be actuated either through an operating lever **17** or through a sleeve **18** at the bottom of the bearing housing **15**. Mounted on the upper end of the stationary insulator **11** is the distantly disposed stationary contact jaw assembly **20** having leaf backup springs **21** for receiving the flattened, beavertail contact portion **23** of the switch blade **24** in high pressure contact engagement therewith. The jaw contact **20** is secured to a contact adapter **25** which is rigidly affixed to the upper end of the stationary insulator **11**. The adapter **25** carries an arcing horn **27** and together with a terminal clamp **28** provides a terminal connector for securing a corresponding line conductor. Attached to the free end of the switch blade **24** is an arcing loop **30** which cooperates with the arcing horn **27**.

At its upper end, the stationary insulator **12** carries one end of a frame support **32** having a terminal pad **33** which together with a terminal clamp **34** provides a terminal connection for a corresponding line conductor **35**. The inner end of the frame support **32** rotatably journals the upper end of the rotatable insulator **14** and the blade operating mechanism. The frame support **32** is a casting comprising horizontally spaced inclined sides **36** terminating at their inner end in a U-shaped cradle **37** (see Figs. 8 and 9) having an approximately horizontal cross piece **39** connecting upwardly extending, horizontally spaced trunnions **40** and **41** for pivotally mounting a U-shaped blade guide **43** about a horizontal axis.

The blade operating mechanism includes a crank **44** rotatable with and secured to the upper end of the rotatable insulator **14**. The crank **44** houses a ball bearing **46** (see Fig. 6) the inner race of which is rigid with the cross piece **39** and the outer race of which is integral with the crank **44** to rotatably journal the upper end of the rotatable insulator **14** on the frame support **32**. The free ends of the legs of the U-shaped blade guide **43** receive pintles **47** extending through the trunnions **40** and **41** to pivotally mount the blade guide **43** on the frame support **32** about a horizontal axis and to provide a fulcrum about which the switch blade **24** swings in its connect and disconnect motions with the distantly disposed stationary contact jaw **20**. The cross piece of the U-shaped blade guide **43** includes a tubular sleeve portion **49** having its axis perpendicular to a vertical plane through the horizontal axis defined by the pintles **47** and disposed below a horizontal plane through said horizontal axis. A cylindrical blade carriage **50** is coaxial with and rotatably journalled within the tubular sleeve portion **49**. The switch blade **24** extends through and is rigidly affixed to the blade carriage **50** by means of a bolt **51** (see Figs. 4 and 6). A stationary jaw contact assembly **52**, similar to the jaw contact assembly **20**, and having backup leaf springs **53** is affixed to the frame support **32** and extends forwardly in a horizontal direction. At the end opposite the beavertail portion **23**, the switch blade **24** is provided with a contact portion **54** (see Figs. 4 and 6) for high contact pressure engagement with the contact jaw assembly **52**.

A pin **55** pivotally connects a bifurcated arm **56** integral with and depending from the blade carriage **50** in the closed, or normal, position of the switch blade **24** to a bifurcated link **57** about a pivotal axis disposed below and transversely related to the longitudinal axis of the switch blade **24**. The link **57** thus maintains a radial relationship relative to the switch blade **24** and to the blade carriage **50** regardless of their rotation. The opposite end of the link **57** is universally connected to the free end of the crank **44** by a ball and socket **59**. In the normal position of the switch the pivotal and universal connections **55** and **59** respectively of the link **57** are disposed on opposite sides of a vertical plane through the horizontal axis defined by the pintles **47** and are also on opposite sides of the vertical axis about which the rotatable insulator **14** rotates. It will also be noted that both the pivotal and the universal connections of the link **57** are below a horizontal plane coincident with the horizontal axis defined by the pintles **47** and below the horizontal axis coincident with the longitudinal axis of the blade **24**.

Rotation of the rotatable insulator **14** results in movement of the ball and socket **59** in an arcuate path in a horizontal plane. The resulting force at the pivotal connection of the link **57**, i. e., at the pin **55**, is a push having a first component approximately axial of the pin **55** tending to rotate the switch blade **24** about its longitudinal axis and a second component vertically upward tending to swing the blade guide **43**, with the switch blade **24** mounted thereon, about the horizontal axis defined by the pintles **47**. During the initial rotation of the rotatable insulator **14**, the first component, i. e., the component approximately axial of the pin **55**, predominates and there is little or no rise of the blade **24**. After the switch blade **24** has rotated sufficiently to break the beavertail portion **23** free from the stationary contact jaw **20**, as well as the contact portion **54** free from the

stationary contact jaw **52**, the second component, i. e., the vertical component tending to swing the switch blade **24**, increases and the switch blade **24** continues to rotate about its longitudinal axis as it is swung in a vertical plane out of engagement with the stationary contact jaws **20** and **52**.

The path of the ball and socket **59** during the initial rotation of the rotatable insulator **14** is approximately perpendicular to the plane of swinging movement of the switch blade **24**, i. e., the crank **44** rotates from a position beyond dead center to the plane of swinging movement of the switch blade **24** and beyond said plane in a path which varies only a few degrees from a straight line perpendicular to the plane of swinging movement of the switch blade **24**. Inasmuch as the pin **55** providing the pivotal connection between link **57** and depending arm **56** is also approximately perpendicular to the plane of swinging movement of the switch blade **24** at the closed position of the switch, during the initial rotation of the rotatable insulator **14** the predominant component of the resulting force at the pivotal connection of the link **57** with the arm **56**, i. e., at the pin **55**, is axial of the pin **55**.

As seen in Fig. 11 switch blade **24** drops approximately one degree during the first ten degrees of crank rotation, rises approximately one degree during the second ten degrees of crank rotation, and the blade rise after thirty degrees of crank rotation is only approximately three degrees. As seen in Figs. 11 and 12*a*, after the first twenty degrees of crank rotation, the switch blade **24** is still at its initial position within the stationary contact jaw **20** and has rotated substantially twenty-six degrees to break the blade **24** free from the stationary contact jaws **20** and **52**. Thus, substantially all of the force available for operating the blade **24** is translated into blade rotation before the switch blade **24** begins to rise in the stationary contact jaw **20**. A maximum of the operating effort of the actuating mechanism is expended in blade rotation during the initial rotation of the rotatable insulator **14** to break the switch blade **24** free of the stationary jaw contact, to minimize contact abrasion, and to provide maximum mechanical advantage for breaking ice before the switch blade **24** begins to rise.

After the switch blade **24** is released from stationary jaw contacts **20** and **52**, the operating forces are increasingly transferred to cause blade rise at a higher rate in relation to blade rotation. This will be better understood when it is considered that with continued blade rotation the axis of the pin **55** departs more and more from the horizontal and approaches the vertical. In other words, the vertical component of the push at pin **55** resulting from rotation of insulator **14** increases with blade rotation. At the disconnect position, the switch blade **24** has swung beyond the vertical position and has rotated through more than 100 degrees. Reverse motion applies when the blade **24** enters the stationary contact jaw **20**, thus providing the most effective ice breaking movement possible if the switch is iced open. On closing, as the switch blade **24** comes down, there is no silver to silver contact until the switch blade **24** is completely in the stationary contact jaw **20**. Blade rotation at this point against the preloaded contact shoes of the stationary contact jaws **20** and **52** establishes full contact pressure. Obviously, when the blade **24** has moved into the jaw contact, substantially all operating forces are translated to rotation of the blade and therefore any ice on the contacts will be cracked off by reason of the added contact pressure and consequent movement of the contact shoes.

The link **57** includes a portion at its bifurcated end which, in the closed position of the switch, is approximately in the plane of swinging motion of the switch blade **24** and a portion **61** (see Figs. 8 and 10) angularly offset therefrom and terminating in a socket for the ball and socket joint **59**. The offset permits the crank to be rotated past the plane of swinging motion of blade **24**, i. e., past dead center, and thus locks the switch in closed position. The crank **44** extends radially of the vertical axis normally to the rear of the switch, i. e., toward the stationary insulator **12** and disposed to one side of the plane of swinging motion of the switch blade **24**. The offset portion **61** of the link **57** is in alignment with the axis of the pin carrying the ball of the ball and socket joint **59** and permits the free end of the crank to be disposed to one side of the plane of swinging motion of the switch blade **24**, i. e., past dead center. It will be appreciated that any force acting directly upon the switch blade **24** tending to open the switch must rotate the crank **44** to the plane of swinging motion of the blade **24**, i. e., to dead center and beyond if the switch blade **24** is to be opened. Thus the switch blade **24** is effectively locked in the closed position.

The above described construction and operation will become evident from the following detailed description of the cooperating parts in reference particularly to Figs. 2 to 12*f* inclusive.

The ball bearings (not shown) enclosed in the bearing housing **15** are preferably silicone grease lubricated and sealed with silicone cord rings as described in detail hereinafter. Such silicone grease has practically flat viscosity temperature characteristics between minus 100 degrees F. and 300 degrees F. The bearing for the rotatable insulator **14** provides low friction under all types of adverse conditions such as chemical fumes, cold, heat, dust, and flyash, and the details of construction of the bearing are disclosed in my copending application Serial No. 409,694 having the same assignee as the present invention. As described therein the operating lever **17** for actuating the rotatable insulator **14** has serrations (not shown) which engage similar serrations on a face plate **78** (see Fig. 1), affixed to the rotatable insulator **14** by bolts **80** to permit the operating lever **17** to be assembled on either side of the face plate **78** and to be positioned within 2½ degrees of the ideal location over a full range of 360 degrees.

The details of the contact jaw assembly **20** are disclosed in the copending application of Walter Kowalski and James J. Seaquist, Serial No. 388,734 having the same assignee as the present invention, to which reference is made for details of construction. As best shown in Fig. 2, two upstanding, laterally spaced contact shoes **85** preferably of hard drawn copper have approximately right angle bends to form base portions **87** facing in opposed relation at their ends. Hexagon head machine screws **89** secure the base portions **87** rigidly to the contact adapter **25** which acts as the bottom half of the terminal connector. Both the adapter **25** and the terminal clamp **28** are provided with crossed V-grooves of different dimensions on both faces thereof. The terminal clamp **28** may be turned and reversed relative to the adapter **25** to either of four possible positions to receive and tightly clamp conductors or tubing ranging in sizes from $\frac{5}{32}$ inch to $1\frac{5}{16}$ inches diameter. This terminal arrangement eliminates one current interchange point on each end of the switch, since the conventional terminal lug is not required. It will be appreciated that the conductor can enter the terminal connector from either of three directions in the horizontal plane. Although not shown in the drawing, the clamping surfaces of each groove of the terminal clamp **28** are preferably provided with serrations to insure gripping of the conductor. The clamping surfaces of the V-grooves in the contact adapter **25** are preferably smooth and the ends are preferably rounded so that a stress concentration will not occur where the cable enters the clamp, thus preventing the conductor materials from crystallizing due to vibration or oscillation of the conductor in service.

A tie-bar **94** projects through registering elongated holes (not shown) in each of the contact shoes **85**. The tie-bar **94** has a spacer portion **95** integral therewith interposed

between the contact shoes 85 to limit the extent of their movement toward each other.

The leaf spring assemblies 21, or backup springs, each comprise three heavy leaf springs of different lengths resiliently bearing against the contact shoes 85 and urging them against opposite margins 96 of the spacer portion 95. The leaf springs of each spring assembly 21 are provided with congruent holes (not shown) which encompass the tie-bar 94. The upper end of the longest leaf 97 of each spring assembly 21 bears against a rectangular copper pad 100 silver soldered to the outer face of the shoes 85 above the margin 96 of spacer portion 95, whereas the lower end of the longest leaf 97 of each assembly 21 bears against the contact adapter 25 and embraces an anchoring pin 102 extending laterally from the contact adapter 25. Elongated holes provided near the ends of the tie-bar 94 accommodate transverse stop pins 103 which hold the preloaded leaf spring assemblies 21 against the contact shoes 85. By the insertion of perforated shims 105 over the anchoring pins 102, increased loading of the leaf spring assemblies 21 against the contact shoes 85 can be accomplished.

It will be appreciated that high contact pressure is provided and uniformly maintained by the leaf springs of the spring assemblies 21 held by the tie-bar 94. These leaf spring assemblies 21 preload the contact shoes 85 prior to entrance of the switch blade 24 into the stationary contacts and enable the twisting motion of the blade 24 to establish full contact pressure with practically no movement of the contact shoes 85. The stationary contact assembly 20 is adjusted so that the contact shoes 85 are preloaded against the spacer portion 95 of the tie-bar 94 at approximately 70 percent of full pressure load and allow the beavertail portion 23 of the switch blade 20 to enter the contact shoes 85 before the blade is rotated to its final position. Thus, operating effort is minimized when establishing full contact pressure, thereby reducing the strain on the operating mechanism and greatly increasing switch life. The pads 100 directly behind the point of contact of the switch blade 24 with the contact shoes 85 provide means to distribute and dissipate possible heating during normal operation and supply reserve thermal capacity under short circuit conditions. Silver inserts 106 (see Fig. 3) on the blade side of the contact shoes 85 exert high contact pressure on mating silver inserts 107 on the curved sides of the flattened beavertail portion 23 of the blade 24 to provide maximum conductivity at the contact points.

The terminal pad 33 on frame support 32 is similar to the contact adapter 25 and has crossed V-grooves on the upper face thereof, and the terminal clamp 34 is identical to the clamp 28 and has crossed V-grooves provided with serrations in both faces thereof. It will be appreciated that the terminal connector formed by pad 33 and clamp 34 permits clamping of a wide range of conductor or tubing size and further eliminates one current interchange point in a manner similar to the terminal connector on the stationary insulator 11.

The details of the rotatable bearing for the upper end of the rotatable insulator 14 are best illustrated in Fig. 6. The crank 44 is a casting having a circular body portion provided with a cylindrical axial compartment 111 concentric with the vertical axis about which the rotatable insulator 14 rotates and a portion 112 extending upwardly at an angle of approximately 50 degrees to the horizontal. The compartment 111 accommodates the double row, radial ball bearing 46. An externally threaded retaining collar 114 engaging internal threads in the compartment 111 holds the ball bearing 46 within the compartment 111. A depending cylindrical boss 115 coaxial with the vertical axis about which the insulator 14 rotates is provided on the bottom surface of the cross piece 39, and a threaded hole 116 is provided through the boss 115. The boss 115 extends through a clearance hole 117 in the crank 44 into the compartment 111 to insure proper alignment of the upper end of the rotatable insulator 14 with the frame 32. The boss 115 abuts against the inner race of the ball bearing 46, and a headed crank bearing bolt 118 projecting through the ball bearing 46 and threaded within the hole 116 engages a nut 119 above the cross piece 39 to maintain the inner race of the ball bearing 46 rigid with the frame 32. Inasmuch as the crank 44 is secured to the rotatable insulator 14 and is held rigid with the outer race by collar 114, the upper end of the rotatable insulator 14 and the crank 44 are rotatably journalled on the inner end of the frame 32.

The ball bearing 46 is preferably lubricated with silicone grease, and a silicone cord ring 120 between the collar 114 and an arcuate-in-cross section circumferential groove in the head of the crank bearing bolt 118 protects and seals the ball bearing 46 from entrance of foreign matter such as water which might freeze or initiate corrosion. The silicone cord ring 120 is a synthetic elastic ring which has uniform physical characteristics in temperature ranges from minus 100 degrees F. to 300 degrees F. and is unaffected by acids or corrosive or salt atmospheres. The advantages of such silicone cord ring seals between relatively moving parts of a disconnect switch are described in detail hereinafter.

The U-shaped blade guide 43 is pivotally mounted between the trunnions 40 and 41 on a horizontal axis and is adapted to swing the switch blade 24 in a vertical plane to connect and disconnect it with respect to the distantly disposed stationary contact jaw 20. Cup shaped portions 122 on the free ends of the legs 123 and 124 respectively of the U-shaped blade guide 43 receive the pintles 47 (see Fig. 8) extending through and engaging congruent threaded holes in the trunnions 40 and 41 respectively to pivotally mount the blade guide 43 on the frame 32 for swinging movement about a horizontal axis thereby providing a fulcrum for the swinging movement of the switch blade 24. The U-shaped blade guide 43 is preferably a casting, and the cross piece thereof includes the tubular sleeve portion 49 having an axis which, as the blade guide 43 pivots, defines a vertical plane perpendicular to the horizontal axis defined by the pintles 47. The axis of the sleeve portion 49 substantially coincides with the longitudinal axis of the switch blade 24.

Ball bearings 128 and 129 rotatably journal the cylindrical blade carriage 50 within the sleeve portion 49 in coaxial relation therewith. Arcuate-in-cross section circumferential grooves 132 and 133 provided in the inner periphery of the sleeve portion 49 at the front and rear ends thereof form outer races for the ball bearings 128 and 129 respectively. A radially extending collar 134 on the cylindrical blade carriage 50 intermediate its ends prevents forward axial movement of the carriage 50 within the sleeve portion 49 and retains the ball bearings 129 within their race. An arcuate-in-cross section circumferential groove 136 in the blade carriage 50 at the base of the collar 134 provides an inner race for the ball bearings 129.

A radially extending collar 137 rigidly secured within a circumferential groove on the exterior surface of the cylindrical blade carriage 50 near the front end thereof prevents rearward axial movement of the carriage 50 within the sleeve portion 49 and retains the ball bearings 128 within their race. In manufacture a reduced outer diameter is provided on the carriage 50 at the front end thereof, and after the collar 137 has been inserted over the reduced diameter portion, the front end of the carriage 50 is spun or staked over the collar 137 to rigidly assemble these parts. An arcuate-in-cross section circumferential groove 138 in the exterior periphery of the collar 137 provides an inner race for the ball bearings 128.

The ball bearings 128 and 129 are preferably lubricated with silicone grease which has practically flat viscosity temperature characteristics between minus 100

degrees F. and 300 degrees F. The exterior edges at both ends of the sleeve portion 49 are bevelled annularly at approximately 55 degrees to the axis of sleeve portion 49 forming inclined surfaces 140 and 141, and the surfaces 143 and 144 of the collars 134 and 137 adjacent the surfaces 140 and 141 respectively are also chamfered annularly at approximately 55 degrees to the axis of sleeve portion 49 but at the opposite angle to which the surfaces 140 and 141 are bevelled. The opposed inclined surfaces 140 and 143 and the opposed inclined surfaces 141 and 144 form annular V-grooves in which silicone cord rings 146 (see Figs. 4 and 5) are inserted to seal and protect the ball bearings 129 and 128 from the entrance of moisture or other foreign matter. The silicone cord rings 146 are synthetic elastic rings which have uniform physical characteristics over substantially the same temperature range as the silicone grease. Acids, corrosive or salt atmospheres, or sunlight has no deleterious effect on the life of the silicone material. Permanent lubrication of the ball bearings is thus provided for the life of the switch. It will be appreciated that the elastic O-rings 146 permit flushing out a bearing by grease fed under pressure internally of the bearing if it would ever be necessary to change grease in the bearing. For example, grease fed under pressure through a hole (not shown) in the sleeve portion 49 into the space between the sleeve portion 49 and the carriage 50 would flow to the ball bearings 128 and 129 and flush the old grease past the elastic O-rings 146.

In addition to sealing the bearings 128 and 129, the silicone O-ring 146 causes any ice accumulated over it, from the stationary sleeve portion 49 to the rotatable carriage 50, to be subjected to cantilever stress when the switch operates. Ice in this condition is weakest, and therefore ice breaking ability is assured.

The elongated switch blade 24 extends axially through the blade carriage 50 and is rigidly secured thereto by bolt 51. The switch blade 24 is of extruded hard drawn copper tubing. The front end of the tubular blade 24 is flattened to provide the beavertail portion 23 having equal radii on both sides so that its total width is constant across the contact sides. In other words, the radius of the sides 148 and 149 of the beavertail portion 23 are equal and have the longitudinal axis of the blade 24 as a center.

High pressure point contact is accomplished in the disconnect switch of the invention by having the curved surfaces 148 and 149 of the beavertail portion 23 at nearly right angles to the curved surfaces of the contact shoes 85. However, in the switch of the invention the total pressure remains constant and at a maximum, even though the blade 24 has overtraveled or undertraveled in rotating. The conductivity is a function of pressure applied between the points of contact, and the total pressure exerted is caused by contact shoe deflection when the blade is closing. Since the total width of the beavertail portion 23 is constant over a given blade twist, the total pressure will be constant over this same blade twist. As shown in Fig. 3, even if the blade 24 is rotated from the full line position to the dotted line position, the total pressure remains constant. This follows because the radius of the curved surfaces 148 and 149 are equal and have the longitudinal axis of the switch blade 24 as the center. As described hereinbefore, silver inserts 107 are provided on the switch blade 24 at the surfaces 148 and 149 where point contact with the contact shoes 85 is obtained. Back-up material (not shown) is placed directly behind the silver insert contact points 107 to give added thermal capacity.

The contact points of a switch blade, when subjected to adverse atmospheric conditions, often become coated with a surface film. Surface films of copper oxide form a very high resistance and become comparatively thick and difficult to remove. The silver oxide or silver sulfide surface films on the contact points of the switch of the invention are very thin and can easily be removed with the wiping action of silver inserts 107 on the switch blade 24 against the silver inserts 106 on contact shoes 85.

The beavertail portion 23 of the switch blade 24 is made narrow to provide minimum travel when rotating into position between contact shoes 85. In addition the narrow tip reduces the operating effort required to relieve the blade 24 from the stationary contact jaw 20 under adverse ice or corrosion conditions. The narrow blade tip with minimum travel when rotating into position provides sufficient wiping action but minimizes the silver to silver wear and still maintains the desired high contact pressure.

The stationary contact jaw assembly 52 engaged by the contact portion 54 at the rear end of the switch blade 24 is similar to the contact jaw assembly 20 and is mounted on a vertically extending flange 151 (see Fig. 4) integral with the frame support 32 and disposed between the rotatable insulator 14 and the stationary insulator 12. A horizontally disposed spacer bar 153 and opposed, horizontally positioned, generally L-shaped contact shoes 154 are rigidly affixed to the frame support 32 by bolts 157 extending through clearance holes in the flange 151, in the spacer bar 153, and in the cross bars of the L-shaped contact shoes 154. Elongated holes (not shown) through the contact shoes 154 accommodate a tie-bar 158 with a spacer portion 159 disposed between the contact shoes 154 to limit the extent of their travel toward each other. Congruent holes (not shown) are provided through the three leaf springs of each backup spring assembly 53 to receive the tie-bar 158, and transverse pins 160 extending through holes in the ends of the tie-bar 158 hold the preloaded back-up springs 53 against the contact shoes 154.

One end of the longest leaf 161 of each backup spring assembly 53 bears against a pad, or block, of copper 162 silver soldered to the back of a contact shoe 154 behind the point of contact with the contact portion 54 of the blade 24 to distribute and dissipate heat, particularly during short circuit. The opposite end of the longest leaf 161 of each backup spring assembly 53 is perforated and embraces an anchoring projection 163 at the end of the spacer bar 153, and it is apparent that the preloading of the backup springs 53 can be varied as desired by the insertion of shims over the anchoring projection 163. The backup spring assemblies 63 preload the contact shoes 154 against the spacer portion 159 at approximately 70 percent of full load pressure and allow the contact portion 54 of the switch blade 24 to enter between the contact shoes 154 before the blade is rotated to its final position.

The switch blade 24 is deformed at its rear end to provide contact portion 54. At the diametrically opposite curved sides of contact portion 54 where point contact with shoes 154 is provided the diameter is equal to that of blade 24, but at diametrically opposite portions 164 (see Figs. 6 and 9) perpendicular thereto the blade diameter is reduced to permit the blade 24 to freely enter and rotate within stationary contact jaw 52. The reduced diameter at the rear end of the blade 24 at right angles to contact portion 54 is made less than the width of spacer 159, thus allowing the blade 24 to swing and rotate freely within jaw contact 52 after it has rotated sufficiently to break contact portion 54 free of contact shoes 154. The radii of the curved sides of contact portion 54 are equal and have the longitudinal axis of blade 54 as a center, in the manner similar to beavertail portion 23, to provide constant contact pressure regardless of overtravel or undertravel of contact portion 54 within contact jaw assembly 52.

Although the diameter of contact portion 54 is less than the width of beavertail portion 23, the same high pressure contact is provided at the stationary contact jaw 52 as at the stationary contact jaw 20. The wider

contact portion 23 is required at the distant end of blade 24 because the torque provided to break ice is a function of the width of the contact portion, and a greater torque is required at the distant end of the elongated switch blade 24, which may be several feet in length, than at the rear end of the blade 24 where greater mechanical strength is provided by the shorter torque arm.

The bifurcated arm 56 integral with the blade carriage 50 extends therefrom radially of the longitudinal axis of the switch blade 24. The pin 55 extends through the spaced bifurcated portions, or ears, 165 (see Fig. 8) of the arm 56 and also through the spaced bifurcated portions 166 of the link 57 to provide a pivotal connection between arm 56 and link 57 about an axis which, in the closed position of the switch, the axis of the pin 55 is inclined at a small angle to the horizontal (see Fig. 8) and the switch blade 24 has overtraveled within the stationary contact jaw 20 until the beavertail portion 23 is inclined at a small angle (shown as 6½ degrees in Fig. 12*a*) to the horizontal. As described hereinbefore the contact pressure is constant regardless of overtravel of the blade 24. The overtravel of the blade 24 within the stationary contact jaw 20 results from rotation of crank 44 past dead center to lock the switch blade 24 closed. The arrangement of parts is such that most of the operating effort during the initial rotation of insulator 14 is effective in rotating the blade 24 and there is substantially no blade rise.

As best shown in Fig. 6 a pin 167 extending through the free end of the crank 44 is provided with a ball portion 168 for the ball and socket joint 59. The sidewall of the pin 167 is tapered intermediate the ends thereof. A conical aperture 169 in the end of the crank 44 receives the tapered portion of the pin 167, and a nut 170 threaded on the end of the pin 167 rigidly affixes the pin 167 to the crank 44. A socket 171 in the offset portion 61, i. e., in the portion at the end of the link 57 opposite its pivotal connection with the arm 56, accommodates the ball portion 168, and the edge at the socket 171 is staked over the ball portion 168 to provide a universal connection between crank 44 and link 57. The ball and socket joint is preferably lubricated with silicone grease and an elastic silicone O-ring (see Fig. 5) seals the joint from entrance of foreign matter.

The switch blade 24 drops to its lowest position within the stationary contacts 20 and the crank 44 is at dead center position when the crank 44 and the ball and socket 59 are in the vertical plane of swinging movement of switch blade 24. In the closed position of the switch, the crank 44 extends radially of the vertical axis toward the rear of the switch, i. e., toward stationary insulator 12, and disposed on one side of the plane of swinging movement of blade 24. Normally the link 57 is approximately in the plane of swinging movement of the blade 24, i. e., the reinforcing rib 172 is in this plane, and the portion 61 having the socket 171 is offset from the link 57 at approximately ten degrees to the plane of swinging movement and downward at an angle of approximately 40 degrees to the horizontal. In other words, the axis of the pin 167 carrying the ball 168 extends upwardly from the crank at an angle of approximately 40 degrees to the horizontal and at an angle of approximately 10 degrees to the plane of swinging movement of the blade 24. This construction with the portion 61 offset from the body of the link 57 permits the crank 44 to be normally disposed past dead center, i. e., to one side of the plane of swinging movement of the blade 24. To open the switch, the insulator 14 must be rotated to move the crank 44, and with it the ball and socket 59, transversely through the plane of swinging movement of the blade 24. Thus the blade 24 is effectively locked in closed position in that inasmuch as the crank 44 is normally past dead center, no force acting directly on the blade 24 will open the switch.

The path of movement of the ball and socket 59 during the initial rotation of the insulator 14 varies only a few degrees from a line perpendicular to the plane of swinging movement of the blade 24. As a consequence, during the initial rotation of insulator 14, the crank 44, in effect, translates the link 57 laterally of the plane of swinging movement of the blade 24 with the result that the predominant component of the push at the pivotal connection of link 57 with arm 56 is approximately axial of pin 55. The axis of the pin 55 is normally inclined at a few degrees from a perpendicular to the plane of swinging movement of the switch blade 24, and as the blade carriage 50 rotates during the initial rotation of insulator 14, the axis of pin 55 gradually approaches perpendicularity with the plane of swinging movement of the switch blade 24, becomes perpendicular to this plane, and gradually departs from perpendicularity. Inasmuch as the initial rotation of insulator 14, in effect, causes lateral translation of the link 57 approximately parallel to the axis of pin 55, the initial rotation of insulator 14 results in maximum blade rotation with substantially no blade rise, and a maximum of the operating effort is expended in blade rotation. It is only when the axis of pin 55 departs appreciably from the horizontal that the vertical component of the push at the pivotal connection of the link 57 becomes of sufficient magnitude to begin to pivot the blade guide 43 about the horizontal axis defined by the pintles 47.

Figs. 12*a* to 12*e* show the position of the beavertail portion 23 within the stationary contact jaw 20 for various degrees of rotation of crank 44. In the closed position of the switch, the blade 24 has overtraveled in rotation approximately 6½ degrees past the horizontal and the crank is approximately 10 degrees past dead center. After the first five degrees of insulator rotation, the blade 24 has rotated to the horizontal as shown in Fig. 12*b* and the blade has dropped approximately ½ degree. After ten degrees of rotation of insulator 14, the crank 44 is at dead center and in the plane of swinging movement of blade 24, the blade 24 has rotated 6½ degrees beyond the horizontal as shown in Fig. 12*c*, and the blade has dropped approximately one degree. After 15 degrees of insulator rotation the blade has rotated 13 degrees beyond the horizontal, i. e., a total of 19½ degrees, as shown in Fig. 12*d* and the blade 24 has risen approximately ½ degree. It will thus be appreciated that the blade operating mechanism supports the switch blade 24 throughout its entire connect and disconnect motion and that no stop is required to prevent dropping of the blade. As explained hereinbefore, in certain prior art switches the blade would normally drop during initial insulator rotation and a stop was required to prevent downward movement of the blade. In forcing the blade against the stop of such prior art switches the parts of the operating mechanism were unduly strained, an unnecessarily large operating effort was required, and switch life was considerably reduced. The operating mechanism of the switch of the invention has high mechanical strength to support the switch blade throughout its entire connect and disconnect motions, thus obviating the need for a stop, reducing operating effort, and eliminating unnecessary strain on the parts of the blade actuating mechanism.

After 20 degrees of insulator rotation the blade 24 has rotated 19½ degrees past the horizontal, i. e., a total of 26 degrees, as shown in Fig. 12*e*. Thus after the first 20 degrees of insulator rotation the blade 24 is still at its initial position within the stationary contact jaw 20 and the blade has rotated a full 26 degrees to break the blade 24 free from the contact shoes 85. From Fig. 11 it will be noted that when the blade 24 has rotated 40 degrees the blade rise is only three degrees; that the blade 24 has rotated a full 48 degrees while rising only six degrees; and that at the top of the contact shoes 85 the blade 24 has rotated 56 degrees while rising only nine degrees. Curves plotting blade rotation and blade rise for the switch of the invention in comparison to prior art switches

show that the blade rise in the switch of the invention is delayed until after a much greater rotation of the blade than in any prior art switches. It will be appreciated that such high ratio of blade rotation to crank rotation, and the complementary small ratio of blade rise to crank rotation, of the switch of the invention in comparison to prior art switches provides maximum operating effort for breaking ice or possible corrosion and assures that the beavertail portion **23** is free of the contact shoes **85** before blade rise is initiated. It will further be appreciated that the blade motion is smooth and continuous without high spots or stops in the operating action.

The switch blade **24** continues to simultaneously rise and rotate about its longitudinal axis until at the disconnect position the switch blade **24** has swung slightly past the vertical and has rotated through a total of approximately 113 degrees. The blade actuating mechanism in the disconnect position of the blade **24** is shown in Figs. 7 and 9. In Fig. 7 the rear end of the switch blade protruding through the carriage **50** has been omitted to better illustrate the arrangement of the parts. In the disconnect position the crank **44** is approximately perpendicular to the plane of swinging movement of the blade **24**, the blade carriage **50** has been rotated until the axis of pin **55** is approximately horizontal, and the link **57** is approximately vertical. Continued rotation of the insulator **14** is prevented by a stop (not shown) within the bearing housing **15**.

Although the blade **24** is past the vertical and stays without support in disconnect position, it is not locked in open position, and a minimum of operating effort is required to initiate closing of the switch blade **24**. A horizontally extending arm **173** on the frame support **32** prevents swinging of the blade **24** in a direction away from the stationary jaw contact **20** at the beginning of the connect motion of the switch blade **24**. In the disconnect position of the switch blade **24**, the link **57** does not abut against the arm **173**. However, it is possible at the initiation of the connect motion for the blade **24** to swing toward the stationary insulator **12**. To prevent this the arm **173** is provided to cam the link **57**, and thus the switch blade **24**, in a downward direction toward the stationary contact jaw **20** at the initiation of the downward pivoting of the blade guide **43**.

It will be appreciated that a minimum of current interchange surfaces are provided in the switch of the present invention and that no flexible leads are required between relatively movable parts as were required in certain prior art switches to reduce the voltage drop across the switch. Silver to silver point contact under approximately 175 pounds pressure is provided at both ends of the switch blade to provide maximum conductivity, and thus minimum voltage drop and heating across the switch.

Certain prior art disconnect switches were mechanically weak in that the forces tending to rotate and swing the switch blade were applied at a point forward of the blade guide and not sufficient strength was provided to prevent axial movement of the switch blade in a forward direction. It will be appreciated that in the switch of the invention, wherein the collar **134** and the arm **56** are disposed to the rear of the sleeve portion **49**, maximum mechanical strength is provided to prevent axial movement of switch blade **24** in a forward direction.

It is apparent that the switch can be mounted in an upright position as shown in Fig. 1, or it can be mounted in a vertical or an underhung position.

The fact that the forces applied to the blade **24** of the illustrated embodiment, during initial opening movement of the operating mechanism, are substantially all translated to rotation of the blade, may in the main be attributed to the arrangement of the parts wherein the link **57** is pivotally connected with the blade carriage **50** on one side of a vertical plane parallel with the horizontal axis about which the blade guide **43** swings and is universally connected with the crank **44** on the opposite side of that plane at a point located between the vertical axis of the rotatable insulator **14** and the stationary insulator **12**.

In the embodiment described herein, the longitudinal axis of blade rotation is in perpendicular and offset relation to and normally positioned below the horizontal axis about which the blade swings, the vertical axis of insulator rotation is offset laterally to one side of this horizontal axis and intersects the longitudinal axis in normal position of the blade, and the link, connecting the blade carriage and the insulator crank, is pivotally connected with the blade carriage on an axis perpendicular to and below the longitudinal axis and universally connected with the crank at a point below the longitudinal axis and disposed on a side of the vertical axis opposite that on which the link is pivotally connected with the blade carriage.

Although only a single embodiment of the invention has been illustrated and described, it will be appreciated that the invention is not necessarily limited to the particular arrangement disclosed. Since changes and modifications in the foregoing switch construction will be obvious to those skilled in the art and different embodiments of the invention can be made without departing from the spirit and scope thereof, it is intended that all matter shown in the accompanying drawing and described hereinbefore shall be interpreted as illustrative and not in a limiting sense.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. Operating mechanism for controlling an elongated switch blade, said mechanism comprising a fixed support, a guide pivotally mounted on said support for movement about a horizontal axis, a carriage rotatably mounted in said guide for rotation about an axis perpendicular to said horizontal axis offset radially therefrom and normally extending in a horizontal direction below said horizontal axis, said carriage having a bore concentric with its axis for receiving said switch blade, means on said carriage for securing said blade in fixed position in said bore, an arm secured to said carriage and depending therefrom, a crank rotatable about a vertical axis offset in a horizontal direction relative to said horizontal axis and intersecting the axis of rotation of said carriage, and a link pivotally connected at one end with said arm on an axis disposed below and radially relative to said axis of rotation of said carriage, the other end of said link being connected to said crank by means of a universal joint, said connections of said link being on relatively opposite sides of said vertical axis.

2. Operating mechanism for controlling switch blade movement in an electrical switch, said mechanism comprising a stationary support, a blade guide pivotally mounted on said support for pivotal movement about a horizontal axis, a blade carriage rotatable in said guide about an axis perpendicular to said horizontal axis, an arm member secured to and depending from said carriage solely in a first vertical plane wholly spaced from a second vertical plane coinciding with said horizontal axis, a crank member rotatable about a vertical axis and positioned below said carriage, said crank member in normal position extending away from said second vertical plane on a side thereof opposite that of the first vertical plane, and a link having one end pivotally connected with one of said members and the other end universally connected with the other of said members, said connections being normally disposed on opposite sides of said second vertical plane relative to each other and below said carriage.

3. In a disconnecting switch comprising relatively spaced first and second stationary insulators, a rotatable insulator disposed between said stationary insulators and more nearly adjacent the first stationary insulator than the second insulator and rotatable about a vertical axis, a frame support secured to said first stationary insulator and rotatably engaging the rotatable insulator at its upper

end, a jaw contact on said second stationary insulator, a blade guide, and an elongated blade carried by said guide and rotatable about its longitudinal axis, said guide being pivoted about a horizontal axis perpendicular to said longitudinal axis to swing said blade into and out of engagement with said jaw contact; blade operating mechanism comprising, in combination, a collar secured to said blade and having in the normal closed position of said blade a member depending therefrom in a plane perpendicular to said longitudinal axis, a crank member rigidly secured to said rotatable insulator and normally extending radially of said vertical axis toward said first stationary insulator, and a link pivotally connected at one end with one of said members for pivotal movement on an axis normally disposed below and transversely related to said longitudinal axis and universally connected at its other end with the other of said members, said pivotal and universal connections of said link being normally respectively disposed on opposite sides of a first vertical plane coinciding with said horizontal axis and on opposite sides of a second vertical plane through said vertical axis and parallel to said first plane.

4. In a disconnecting switch comprising relatively spaced first and second stationary insulators and a rotatable insulator between said stationary insulators and rotatable about a vertical axis, a frame secured to the first of said stationary insulators and having journal means rotatably engaging the rotatable insulator at its upper end, a jaw contact on the second stationary insulator, a blade guide, and an elongated blade carried by said guide and rotatable about its longitudinal axis, said guide being pivoted on said frame about a horizontal axis above the longitudinal axis of the blade in the normal closed position of the switch blade to permit swinging of the blade into and out of engagement with said jaw contact; blade operating mechanism, comprising, in combination, an arm secured to said blade and depending therefrom in a plane perpendicular to said longitudinal axis, a crank rigidly secured to said rotatable insulator and normally extending radially of said vertical axis toward said first insulator and approximately in a first vertical plane coinciding with said longitudinal axis, and a link pivotally connected at one end with said arm for pivotal movement on an axis normally disposed below and approximately perpendicular to said first vertical plane and universally connected at its other end with said crank, said pivotal and universal connections of said link being normally disposed on opposite sides of a second vertical plane coinciding with said horizontal axis and perpendicular to said first vertical plane, whereby the principal component of the forces at said pivotal and universal connections due to the initial rotation of said rotatable insulator to open said blade will be in a direction to rotate said blade about its longitudinal axis.

5. An electric switch comprising a fixed contact, a switch blade rotatable about its longitudinal axis and pivotally mounted about a horizontal axis normal to said longitudinal axis for swinging movement in a vertical plane relative to said fixed contact, an arm secured to said blade and depending therefrom when said blade engages said contact, a crank movable in a horizontal plane transversely disposed relative to said vertical plane of swinging movement of said blade, and a link pivotally connected at one end with said arm for pivotal movement on an axis normally disposed below and at an acute angle with respect to said horizontal plane and transversely related to said longitudinal axis and at its other end having a portion offset at an angle from said vertical plane and said link providing a universal joint with said crank, said crank having a dead center position when said universal joint is in said vertical plane, said universal joint being normally disposed on one side of said vertical plane and upon initial movement of said crank to open said blade said universal joint is moved transversely across said vertical plane, whereby said blade is effectively locked closed when said joint is on said one side and cannot be moved by forces acting directly on said blade.

6. In an operating mechanism for a disconnecting switch wherein the blade is rotated about its longitudinal axis to provide high contact pressure engagement with a stationary contact, in combination, a rotatable insulator rotatable about a vertical axis, a fixed support rotatably journalling the upper end of said rotatable insulator and having spaced, upwardly extending trunnions, a U-shaped blade guide having the legs thereof pivotally mounted between said trunnions on a horizontal axis, a blade carriage extending through the cross piece of said U-shaped blade guide and being rotatably journalled therein about an axis perpendicular to said horizontal axis, an elongated switch blade extending through and rigidly affixed to said blade carriage, said blade carriage having spaced ears depending therefrom in a plane perpendicular to said longitudinal axis and disposed between said cross piece and said horizontal axis, a crank rigidly affixed to said rotatable insulator and movable in a horizontal plane transversely disposed relative to the plane of swinging movement of said blade, and a link pivotally connected at one end with said ears for pivotal movement on an axis disposed below and transversely related to said longitudinal axis and universally connected at its other end with said crank, said pivotal and universal connections of said link being normally disposed on opposite sides of a vertical plane coinciding with said horizontal axis.

7. In an operating mechanism for a disconnecting switch exposed to atmospheric conditions, a first member providing a bearing, a second member rotatably journalled within said bearing and being rotatable relative to said first member about an axis, said first member having an exterior, peripheral, annular surface concentric with said axis, said second member having an exterior, peripheral, annular surface concentric with said axis and opposite the exterior, peripheral surface of said first member, said exterior peripheral surfaces of said first and second members diverging from each other and jointly defining an annular groove therebetween exteriorly of said members, and a tensioned, elastic, silicone ring of circular cross section in said groove in compressive bearing relation to said surfaces for preventing entrance of moisture to said bearing, the cross sectional diameter of said ring being greater than the width of said annular groove.

8. In a disconnecting switch, in combination, a jaw contact, a blade guide, and a switch blade rotatably mounted on said guide about its longitudinal axis and having a flattened beavertail portion cooperating with the jaw contact, said guide being pivoted about an axis perpendicular to said longitudinal axis to permit swinging said switch blade into and out of engagement with said jaw contact, said beavertail portion having oppositely disposed sides contacting said jaw contact, said sides being arcuate in cross section and having equal radii with the longitudinal axis of the blade as a center whereby substantially uniform contact pressure is maintained in the closed position of the switch blade regardless of rotational overtravel or undertravel of the switch blade in the jaw contact.

9. In a disconnecting switch, in combination, a jaw contact, a blade guide, and a switch blade rotatably journalled on said blade guide about its longitudinal axis and having at one end oppositely disposed contact areas cooperating with said jaw contact, said guide being pivoted about an axis perpendicular to said longitudinal axis to permit swinging said switch blade into and out of engagement with said jaw contact, said contact areas being arcuate in cross section, the radii of curvature of said contact areas being equal and having the longitudinal axis of the switch blade as a center, the areas of said switch blade perpendicular to said oppositely disposed contact areas having radii smaller than those of said contact areas.

10. In an operating mechanism for a disconnecting switch exposed to the atmosphere, a frame support, a rotatable insulator rotatable about a vertical axis, a crank rigidly affixed to the upper end of said rotatable insulator and disposed below said support, said crank having a cylindrical bore concentric with said vertical axis, a cylindrical member rigidly affixed to and depending from said support and rotatably journaled within said bore, said crank and the surface of said frame support opposite thereto jointly defining an annular exterior groove therebetween, and an elastic, silicone ring of circular cross section within said groove preventing entrance of foreign material to said bore, the cross sectional diameter of said ring being greater than the width of said groove.

11. In an operating mechanism for a disconnecting switch, a blade guide having a cylindrical bore and being pivoted on an axis perpendicular to the axis of said bore, a switch blade carriage coaxial with and extending through said bore, ball bearing means rotatably journalling said carriage within said bore, said carriage having radially extending collars adjacent the ends of said bore preventing movement of said carriage in an axial direction, an annular surface on each of said collars being concentric with the axis of said bore and inclined to the axis of said bore, the surface on said guide opposite to said annular surface on said collar being inclined at the opposite angle to the axis of said bore, said inclined surfaces on said guide and said collar jointly defining an exterior, annular, V-groove therebetween, and an elastic silicone ring of circular cross section in said groove preventing entrance of foreign material to said bearing means.

12. In a disconnect switch, the combination of a fixed frame support having spaced sides, a U-shaped blade guide having the legs thereof pivotally mounted for swinging on a horizontal axis transverse to said support, a blade carriage journaled for rotation in said guide on a longitudinal axis perpendicular to said horizontal axis, said carriage being disposed in a portion of said guide intermediate said legs, a switch blade extending through said carriage and adapted to rotate and swing therewith, an arm affixed to said carriage between said horizontal axis and said guide and extending in a radial direction relative to the axis of said carriage, a rotating insulator journaled for rotation with respect to said fixed support,

a crank carried on said insulator for rotation therewith in a single plane normal to said insulator axis, pivot means between the swinging end of said crank and said arm for simultaneously rotating said blade carriage and swinging it about said horizontal axis, spaced contact jaws engageable by said switch blade, one of said contact jaws being disposed within said fixed frame support for engagement by said switch blade at a point on one side of said horizontal axis opposite from the side where the other of said jaws engages said blade.

13. In an operating mechanism for a disconnect switch exposed to atmospheric conditions, a first member provided with a bearing, a second member rotatable about the axis of said bearing adjacent the first member to provide a joint to be sealed between members, at least one of said members having contiguous with said joint an annular surface radially spaced from the axis of rotation and directed away from a plane normal to the axis of rotation and thereby defining an annular ring seat groove in conjunction with a surface on the other member, and a tensioned elastic ring in said groove, said ring being in compressive bearing relation to said surfaces for preventing entry of contaminants into said bearing.

14. In an operating mechanism for a disconnect switch exposed to atmospheric conditions, first and second adjacent members providing a joint to be sealed therebetween and rotatable with respect to each other on a common axis, at least one of said members having contiguous with said joint an annular surface presented outwardly from the axis, radially therefrom and directed away from a plane normal to the axis, said surface thereby defining an annular ring seat groove in conjunction with a surface of the adjacent member, and a tensioned elastic ring in said groove, said ring having a tendency to contract into compressive bearing relation only against said surfaces for preventing contaminants from entering said joint.

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