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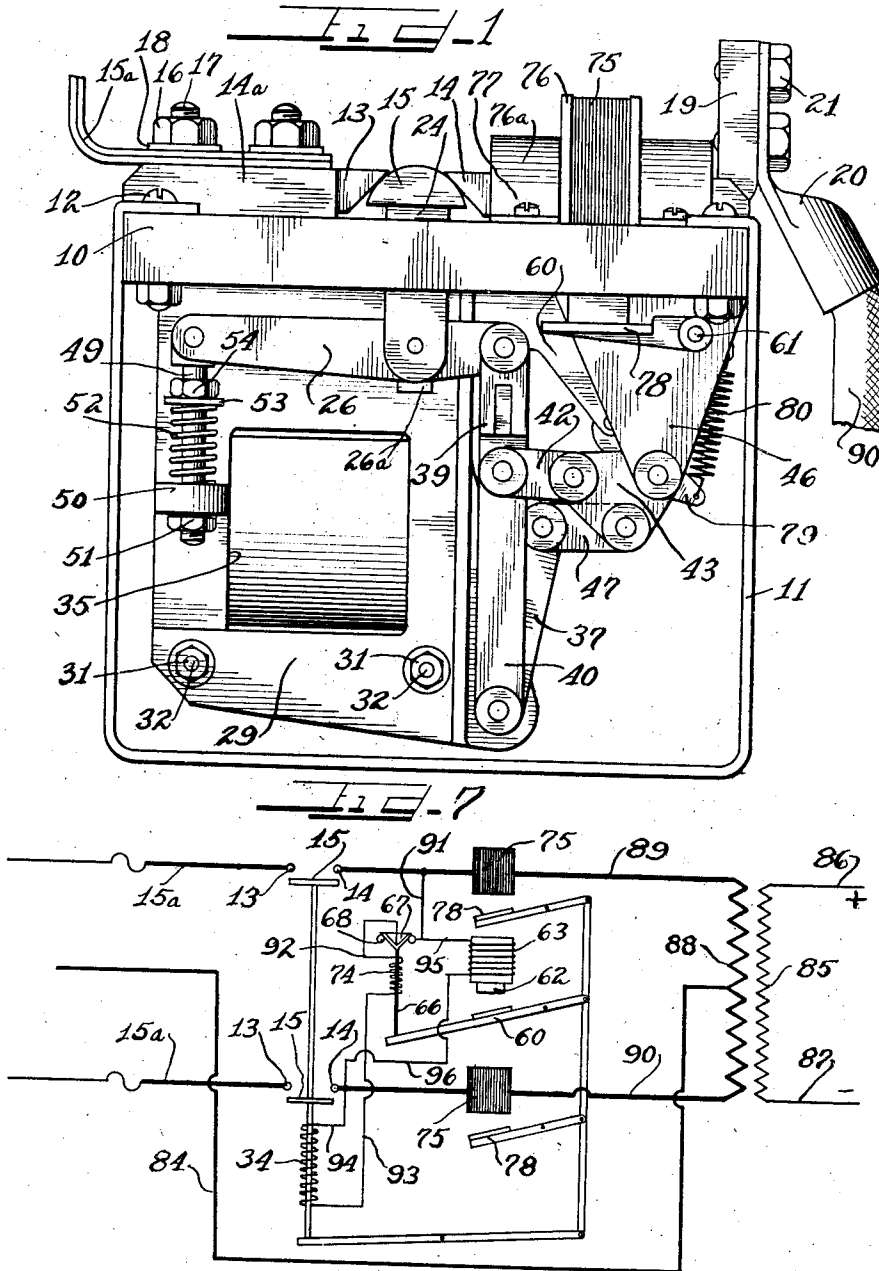
J. J. SHOEMAKER ET AL

2,096,706

AUTOMATIC DISCONNECTING SWITCH

Filed June 3, 1931

3 Sheets-Sheet 1



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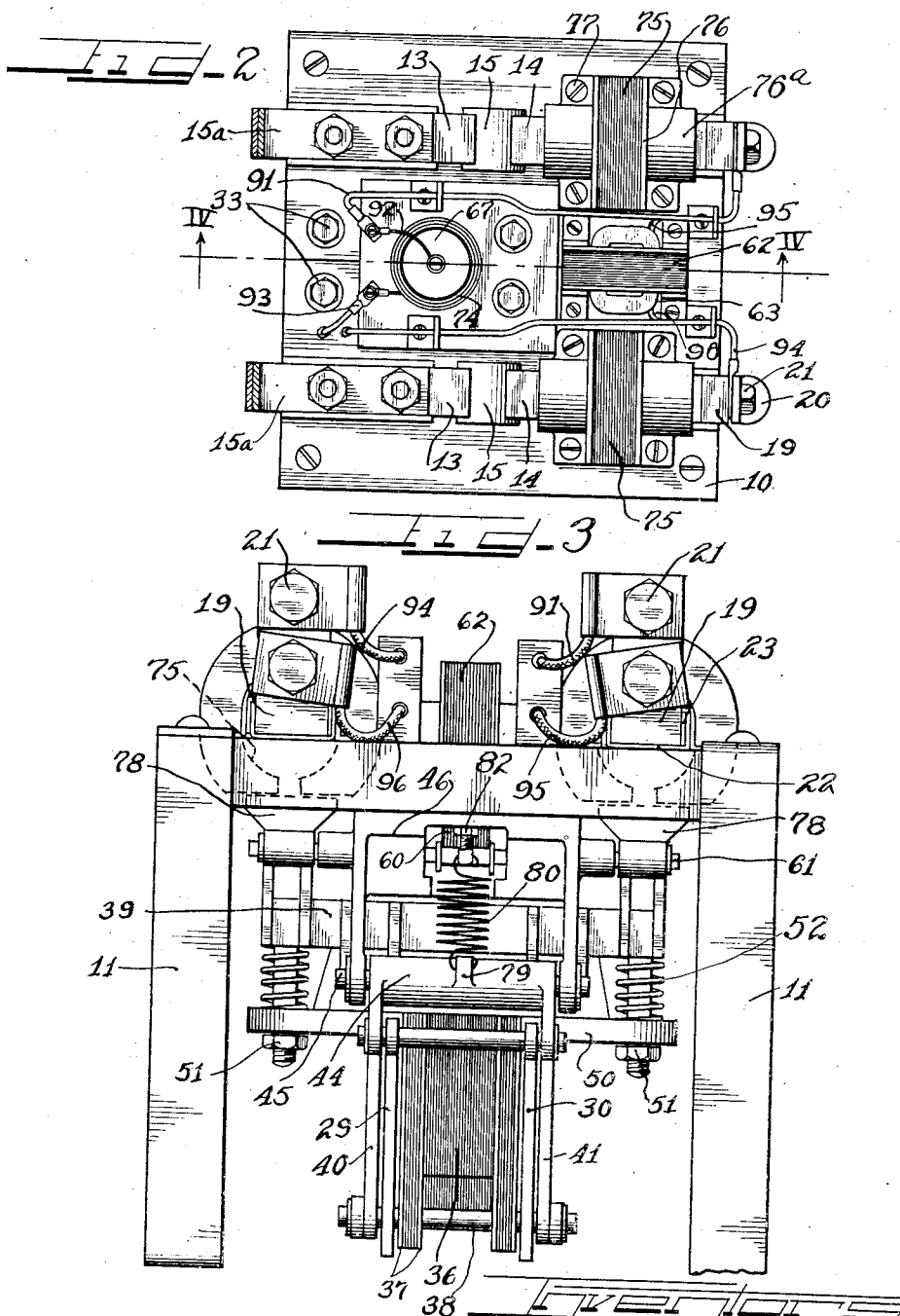
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2,096,706

AUTOMATIC DISCONNECTING SWITCH

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3 Sheets-Sheet 2



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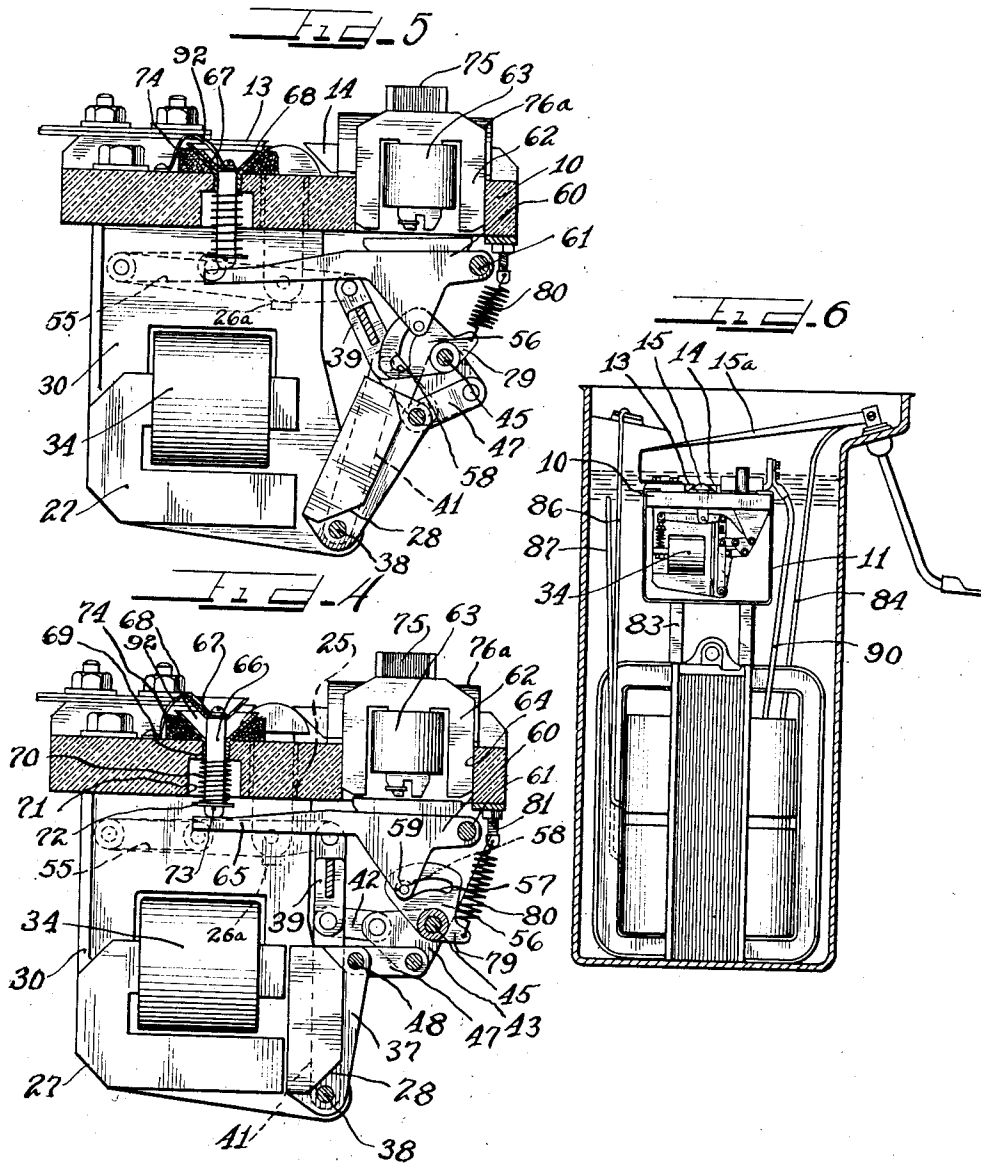
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AUTOMATIC DISCONNECTING SWITCH

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3 Sheets-Sheet 3



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2,096,706

AUTOMATIC DISCONNECTING SWITCH

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Application June 3, 1931, Serial No. 541,776

16 Claims. (Cl. 200—98)

This invention relates in general to electrical switches and is more particularly concerned with improvements in electrically operated switches of the disconnecting type, which are designed for working under voltage and current conditions such as are ordinarily met with in secondary distribution systems, wherein the switch is opened only when there is little or no load on the circuit as distinguished from switches having relatively high interrupting capacity and which are adapted for opening under load conditions.

It is a primary object of this invention to provide in a disconnecting switch, operating means whereby the switch may be closed and opened from a distance by energizing and deenergizing the circuit in which the contacts of the switch are disposed.

It is a further object of this invention to provide in a disconnecting switch, improved means for interlocking the main contacts of the switch in closed position as soon as either current or voltage is established on the circuit in which the switch contacts are disposed, and which will function to open the contacts upon the circuit being entirely deenergized or when both the current and voltage have been reduced to a predetermined value.

It is a further object of this invention to provide a switch having electrically responsive closing means which is mechanically interlocked in closed position, and in which actuation of the interlocking mechanism is effective to deenergize the switch closing means.

It is likewise an object of this invention to provide in a disconnecting device, contacts of the high pressure type which are so designed that any oxidation, dirt and the like thereon will be readily crushed and will not interfere with the establishing of a good electrical circuit through the switch contacts.

It is a further object of this invention to provide in a disconnecting switch, improved auxiliary means for interrupting the closing coil circuit of the switch as soon as the main switch contacts are in closed position.

Another object of this invention is to provide an automatic disconnecting switch which is adapted for mounting in the tank of a transformer so as to form a self-contained distribution device adapted for use in network distribution systems, wherein the primary feed current of the transformer will be effective to energize the operating mechanism of the switch, the switch contacts being disposed in the secondary circuit of the transformer, whereby the secondary leads of the transformer may be auto-

matically opened when the primary supply is opened with the result that back feed through the transformer is prevented.

Other objects of this invention will more fully appear from the following detail description taken in connection with the accompanying drawings which illustrate a single embodiment thereof, and in which

Figure 1 is a side elevation of a disconnecting switch embodying the features of our invention;

Figure 2 is a plan view of the switch showing the main contacts and the relationship of the current and potential elements of the interlocking mechanism;

Figure 3 is an end elevation of the switch;

Figure 4 is a vertical sectional view through the switch showing the main contacts in closed position, and the relative positions of the various elements comprising the interlocking mechanism of the switch, taken substantially on line IV—IV of Figure 2;

Figure 5 is a view similar to Figure 4 except that the main contacts are in open position and the various elements of the interlocking mechanism are in unlatched position;

Figure 6 is a cross sectional view through the tank of a transformer having the switch of our invention applied thereto; and

Figure 7 is a diagrammatic view showing the electrical connections between the elements comprising the switch of our invention.

As shown on the drawings:

In the illustrated embodiment of our invention, we have shown the disconnecting switch as being assembled upon a horizontally disposed panel of insulating material, which is supported on a pair of spaced members 11—11, these members being secured to the panel in any appropriate manner, as by bolts 12.

The disconnecting switch proper consists of stationary contact members 13 and 14 which are arranged for engagement by a cooperating movable contact member 15. The faces of the stationary contact members, with which the movable contacts engage, are arranged at an angle of approximately 45°, the engaging surface of the movable contact member being arcuate in form so that they will be self-aligning and at all times make proper contact with the faces of the stationary contact members.

The stationary contact 13 is in the form of a bar of material of suitable electrical conductivity and is disposed in a channel shaped member 14a of insulating material. The upper surface of the bar forming stationary contact 13 is exposed

for engagement by a terminal connection 15a which is secured against the bar by means of nuts 16 which threadedly engage the ends of bolts 17 which extend through the bar, thereby enabling the nuts 16 to be tightened against associated washers 18 which engage the terminal connection. The nuts 16 also cooperate with the bolts 17 to rigidly secure the stationary contacts 13 against the upper surface of the panel 10.

The stationary contact 14 is likewise secured to the upper surface of the panel 10 and is in the form of a bar of material of good electrical conductivity, the outer end of the bar being deflected to form a right angle portion 19 to which a terminal connector 20 may be secured as by suitable bolts 21 which threadedly engage the bar. This bar is disposed in a channel shaped insulating member 22 which is similar to the member 14a associated with the stationary contact 13. Extending over the upper surface of the bar forming the stationary contact 14 is another channel shaped member of insulating material as shown at 23 which cooperates with member 22 to insulate the bar for a purpose that will be subsequently described.

The movable contact 15 is connected to the upper end of a member 24 which extends downwardly through an aperture 25 in the panel 10 as shown in dotted lines in Figure 4. This aperture is constructed so as to have sufficient clearance to enable slight pivotal movement of the member 24, this member being pivoted at its lower end between the ends of a substantially horizontally disposed member 26. This aperture also serves as a guide for the member 24 when it is moved longitudinally to bring the movable contact 15 into and out of engagement with the stationary contacts 13 and 14. In order to relieve the pivotal connection between members 24 and 26 from excessive strain and wear when closing the switch contacts, member 26 is formed with a projecting portion 26a which abuts the lower end of member 24 as shown in Figure 1.

Power means for closing the main contacts of the switch consist of a magnetizable core 27 operatively associated with an armature 28 which is supported for movement when influenced by the magnetization of the core 27. The core 27 is in the form of a U and is made up of a plurality of laminations which are clamped between spaced frame members 29 and 30 as by nuts 31 which threadedly engage bolts 32. The frame members 29 and 30 extend downwardly from the lower surface of the panel 10 and are secured thereto by bolts 33 which extend through the panel 10 and engage the respective frame members. The core is magnetized by means of a coil winding 34 which surrounds one leg of the core and projects through windows or openings 35 in the frame members 29 and 30. The armature 28 is likewise composed of a plurality of laminations 36 which are secured between a plurality of spaced clamping members 37. These clamping plates together with the outermost laminations are extended and apertured for receiving therethrough a pivot pin 38 having its ends projecting through extended portions of the spaced frame members 29 and 30 so as to form a pivotal mounting for the armature.

Pivotal movement of the armature 28 is transmitted to the movable contacts 15 of the disconnecting switch through a series of interconnected links. Each member 26 is associated with one of the movable contacts of the disconnecting switch and pivotally connected at one end to a

yoke member 39 which is pivotally connected to and cooperates with a pair of link members 40 and 41 disposed on either side of the armature to form a substantially vertical toggle.

The link members 40 and 41 are pivoted at their lower ends on pivot pin 38. This toggle is actuated by means of a substantially horizontal toggle consisting of links 42 and 43, the outer end of the link 42 being pivotally connected to the main toggle at the pivotal connection between its members. The member 43 is in the form of a crank disposed at either end of a cylindrical sleeve 44 which is rotatably mounted on a pivot pin 45 having its ends supported in a bracket 46 secured to and depending from the panel 10. Angularly displaced from the pivotal connection of the member 43 to the link 42, the member 43 is pivotally connected to one end of a link member 47, its other end being pivoted on a rod 48 which extends transversely through the upper portion of clamping members 37 and the outermost laminations of the armature contained therebetween.

The other end of member 26 is floatingly fulcrumed by being pivotally connected to the upper end of a supporting member 49 which extends downwardly through an aperture in a bracket 50 formed on each of the frame members 29 and 30, the lower end of the member 49 being threaded for receiving a nut 51. Disposed around the member 49 above the bracket 50 is a coil spring 52 which is compressed between the bracket and a washer 53 having its upper surface bearing against a nut 54 which threadedly engages the upper portion of member 49. In order to maintain the member 26 and supporting member 49 in proper operative positions, a link 55 is pivoted at one end to each of the frame members 29 and 30, as shown in dotted lines in Figures 4 and 5, the outer end of link 55 being pivotally associated with the pivotal connection between members 26 and 49. The foregoing arrangement provides a floating fulcrum for member 26 and also enables adjustment of the pressure between the movable contact 15 and the stationary contacts 13 and 14 by tightening or loosening the nut 54 against the spring 52. It will also be observed by reference to Figure 1 that, when the contacts of the disconnecting switch are closed, the nut 51 is spaced from the bracket 50, and that, when the movable contact is disengaged from the stationary contact, the spring 52 will force the supporting member 49 upwardly until the nut 51 bears against the under surface of bracket 50. This provides sufficient leeway to compensate for any wear which may take place between the contacts of the switch.

The interlocking mechanism for the switch, which is arranged to lock the toggles in extended position when the contacts of the switch are closed, comprises a cam plate 56 which is secured to the sleeve 44 and is angularly disposed from the crank member 43, Figures 4 and 5. The cam plate 56 is formed with a concentric slot 57 which terminates at one end in an upwardly extending recessed portion 58 which forms a dwell for a roller 59 which is disposed for movement through the slot. The roller 59 is carried by an armature 60 secured to a shaft 61 which is rotatably trunnioned in the bracket 46. The armature 60 is operatively associated with a core 62 which is magnetized by a potential coil 63, the core being supported on the panel 10 and projecting into a suitable aperture 64. By making the recessed portion 58 of the slot 57 substantially half the

diameter of the roller 59, a definite clearance is established between the pole faces of the core 62 and the armature 60, when the armature is in closed position.

5 With the disconnecting switch closed, the recessed portion 58 will be disposed above the roller 59, so that if the coil 63 is energized the armature 60 will be attracted and move the roller into the recessed portion, thereby latching the toggle
10 mechanism in closed position. Since the disconnecting switch is latched in closed position, it is not now necessary to maintain the closing coil 34 energized. In order to open the circuit to this coil an auxiliary switch is provided which
15 is actuated by the movement of armature 60. For this purpose the armature 60 is extended to form an arm 65 which bears against the lower end of a member 66 which is vertically reciprocable relative to the panel 10. Secured to the upper end
20 of the member 66 is a conical shaped member which forms the movable contact of the auxiliary switch. Disposed below the movable contact 67 is a stationary contact 68 which is formed with a conical surface for cooperatively engaging the
25 conical surface of the movable contact, the stationary contact surrounding the member 66 and being secured to the panel 10 by a threaded sleeve portion 69. The movable contact is normally held in engagement with the stationary contact by means of a spring 70 which is disposed within a pocket 71 in the underside of the panel 10 and surrounds the member 66. This spring is compressed between the sleeve portion 69 of the stationary contact and a washer 72 which is secured
30 against downward movement on the member 66 by means of a pin 73. Surrounding the stationary contact is a coil 74 which serves as a blow out coil for any arc which may be formed between the contacts of the auxiliary switch when they are
40 opened.

In the arrangement just described, it will be observed that the flux lines in the magnetic field set up by the blowout coil will, since this coil has an air core, emanate outwardly in a direction
45 substantially parallel to the conical surfaces of the contacts 67 and 68. Any arc which is formed between the contacts will therefore be substantially at right angles to the field flux through which it passes and will be caused to move or be rotated
50 circumferentially around the axes of the contacts, the arcs thereby being carried into cooler portions of the contact surfaces and extinguished without damage to the contacts.

In addition to the potential element of the interlocking mechanism, there is also provided a current element which is associated with each of the stationary contacts 14 and comprises a plurality of circularly formed laminations 75 which surround the member 14 and are insulated there-
60 from by the channel shaped members 22 and 23 of insulating material. These laminations are secured between spaced members 76 in any well-known manner. Outwardly extending from the members 76 and overlying the bar composing the
65 stationary contact 14 is a metallic member 76a which is secured to the panel 10 as by bolts 77, and forms an inductive shield between the current and potential elements of the interlocking mechanism. The laminations 75 extend into
70 suitable apertures in the panel 10 and are arranged for operatively affecting an armature 78, Figure 3, which is secured to and movable with shaft 61. Since the armatures of both the current and potential elements of the interlocking
75 mechanism are fixedly secured to the common

shaft 61, it will be apparent that the disconnecting switch may be locked in closed position by virtue of the energization of either the potential or current elements. In the arrangement of the
5 current interlock or latch just described, it will be observed that the magnetic pull on armature 78, with a given constant current value, may be increased or decreased by increasing or decreasing the number of laminations used to make up
10 cores 75 and armatures 78.

In order to provide means for opening the switch contacts when the current and potential elements of the interlocking mechanism are deenergized, the cam plate 56 is extended to form a
15 lug 79, Figures 4 and 5, which is engaged by one end of a tension spring 80 having its other end secured to an adjustable screw 81 which threaded-ly engages the bracket 46, this screw being provided with a nut 82 by means of which the screw
20 may be locked in adjusted position. By varying the amount of iron in core 75 and armature 78, or increasing or decreasing the tension on spring 80, the switch can be arranged to remain closed with any desired combination of voltage and
25 current within a wide range. Thus, the switch will remain closed under high current and low voltage conditions, but will open with low voltage and low current. In this manner the switch will remain closed when energy is supplied to a short
30 circuit, but will open very quickly when the circuit is de-energized.

Referring to Figure 6, the disconnecting switch of our invention is shown as being applied to a transformer to form a distribution unit which
35 is exceedingly advantageous for use in distribution systems such as disclosed in United States Patent No. 1,979,353.

In this unit the disconnecting switch is supported upon the transformer core structure by means of a plurality of spacer members 83, in such
40 a manner that the switch is preferably disposed below the oil level in the transformer. By thus mounting the switch within the transformer tank, the oil therein serves to insulate the switch from the elements, thereby being conducive to longer
45 life and freedom from trouble due to possible corrosive formations on the various parts. In this form of our invention, the secondary leads of the transformer, that is, the ends of the secondary winding are connected to the stationary contacts
50 14 and the stationary contacts 13 are connected by means of terminal connections 15a to the secondary terminals of the transformer. The central point of the secondary winding is also brought out to a transformer terminal through conductor 84,
55 thereby enabling the distribution unit to be used for either two wire or three wire distribution.

The operation of our invention will be as follows:

Referring to Figure 7, the primary winding 85
60 of the transformer is connected through terminal leads 86 and 87 to an electrical circuit. The secondary winding 88 of the transformer is connected through conductors 89 and 90 to the stationary contacts 14 of the disconnecting switch
65 and the stationary contacts 13 of the disconnecting switch extend through terminal connections 15a—15a.

Energization of the primary winding 85 will
70 put secondary voltage on the stationary contacts 14—14, and excite the coil 34 through the following circuit: from one terminal of the secondary winding of the transformer, through conductor
75 89, conductor 91 through contacts 68 and 67 of the auxiliary switch, conductor 92, blow out coil

74, conductor 93 to one terminal of the coil 34, from the other terminal of the coil 34 through conductor 94 and the conductor 90 to the other terminal of the secondary winding of the transformer. Coil 34 being energized will actuate the contacts 15 of the disconnecting switch into engagement with their associated stationary contacts 13 and 14, thereby applying voltage to the terminal connections 15a.

Simultaneously with the energizing of coil 34, the potential element of the interlocking mechanism is actuated by virtue of coil 63 being energized through the following circuit: from one terminal of the secondary winding of the transformer, through conductor 39, conductor 91, conductor 95 to one terminal of coil 63, from the other terminal of coil 63 through conductor 96 and conductor 99 to the other terminal of the transformer secondary winding. When coil 63 is energized, the magnetized core 62 therein attracts armature 60, which action moves each armature 78 towards its associated magnet and also opens contacts 67 and 68 of the auxiliary switch. Opening of these contacts causes an arc to be formed therebetween due to the inductive effect of the coil 34, but since the current flowing through this arc also flows through the blow out coil 74, which is in series with the contacts 67 and 68, the arc is extinguished.

As soon as load is applied to the transformer, current will flow from the transformer through the contacts of the disconnecting switch and magnetize the laminations 75 which assist the potential element of the interlocking mechanism in maintaining the disconnecting switch contacts locked in closed position. Referring to Figure 5, which shows the interlocking mechanism in non-locked position, it will be observed that the roller 59 on the armature 60 is disposed in the end of slot 57 which is opposite from the end of the slot having the recessed portion 58 therein. When the armature 28 is attracted by the magnet 27 in closing the disconnecting switch, the cam plate 56 is rotated clockwise to the position shown in Figure 4, in which position the roller is disposed beneath the recessed portion 58 of the slot. Now, when the armature 60 is attracted by the magnet 22 as described above, the roller will be moved into the recessed portion and mechanically latch the cam plate 56 against rotational movement.

With either the voltage or current elements of the interlocking mechanism excited, the switch will be maintained interlocked in closed position. However, as soon as both current and voltage have been decreased to a predetermined value, this value being the drop-out value of the respective armatures, or, if the current and potential elements are deenergized by disconnecting the transformer from the electrical supply circuit, the armatures 60 and 78 will be released. Since the armatures are connected to a common shaft, the roller 59 is moved out of the recessed portion 58 of the slot, thus releasing the cam plate 56 which is rotated counter-clockwise by means of the tension spring 80. Rotation of the cam plate 56 will rotate sleeve 44 and the crank members 43 secured thereto, thereby causing the toggles to move the contacts 15 out of engagement with the stationary contacts 13 and 14, the various elements of the disconnecting switch being now disposed as shown in Figure 5.

Now, it is of course to be understood that although we have described in detail the preferred embodiment of our invention, the invention is not to be thus limited but only insofar as defined

by the scope and spirit of the appended claims.

We claim as our invention:

1. In a disconnecting switch, contacts actuable to open and close an electrical circuit, means for actuating said contacts, and means for latching said contacts in closed position, said means being actuable to locking position by current and potential elements connected to said circuit and arranged to be energized when the circuit is energized.
2. In a disconnecting switch, contacts arranged for opening and closing an electrical circuit, means for actuating said contacts, and means for latching said contacts in closed position comprising current and potential elements energizable from said circuit, and a mechanical linkage having a common connection with said elements and actuated to latching position upon the energization of said elements.
3. In a disconnecting switch having relatively movable main contacts for opening and closing an electrical circuit and means energizable to actuate said contacts to closed position; means for de-energizing said first means when the main contacts are closed comprising relatively movable contact members having conical surfaces of engagement, and a blow out coil, so located with respect to said conical surfaces that its flux is substantially parallel to said surfaces.
4. In a disconnecting switch having relatively movable members for opening and closing an electrical circuit and means energizable to actuate said members to closed position; means for de-energizing said first means when the members are closed comprising normally closed contacts having conical surfaces of engagement, and a blow out coil so located with respect to said conical surfaces as to produce rotation of the arc formed between said surfaces.
5. A switch comprising normally closed and relatively movable contacts having conical surfaces of engagement, and a blow out coil parallel to the conical surfaces, said coil and contacts being connected in series.
6. A disconnecting switch comprising spaced stationary contacts, a member resiliently fulcrumed at one end, a toggle mechanism connected at the other end of said member, electro-responsive means for actuating said toggle mechanism, and a contact member connected to and reciprocable by said first member into engagement with said stationary contacts when said electro-responsive means are energized, said resilient fulcrum being so mounted with respect to the contacts and having parts cooperative in such a manner as to oppose the separation of the contacts when they are in engagement.
7. A disconnecting switch comprising stationary contacts, a link member resiliently fulcrumed at one end, a toggle mechanism connected at the other end of said link member, electro-responsive means for actuating said toggle mechanism, a reciprocable contact member connected to said link for bridging said spaced contacts when said electro-responsive means is energized, and means for adjusting said fulcrum to vary the engagement pressure between said contacts.
8. In a switch, contacts actuable to open and close an electric circuit, means to close said contacts, and means for latching said contacts in closed position including a potential element and a pair of current elements energizable from said circuit, said elements having separate magnetic circuits and relatively disposed with the potential element between the current elements.

9. In a disconnecting switch having contacts actuatable to close and open an electrical circuit, control means for said contacts including coil means responsive to the circuit potential and coil means responsive to the circuit current, and latch means controlled by said coil means and operative to maintain said contacts in latched position upon energization of either of said coil means, and enable said contacts to move to open-circuit position when said current and said voltage both reach a predetermined low value.

10. In a disconnecting switch having contacts actuatable to close and open an electrical circuit, control means for said contacts including coil means responsive to the circuit potential and coil means responsive to the circuit current, said control means maintaining said contacts in latched position upon energization of either of said coil means, and connecting means between said coil means whereby said circuit may be opened when said current and said voltage both reach a predetermined low value.

11. In a switch control means for an electrical circuit, means including a toggle to maintain the switch closed, a circuit current coil, a circuit potential coil, and toggle operating means associated with said coils, said latter means being operative to open said circuit when the current and voltage respectively of said coils reaches a predetermined low value.

12. In a switch control means for an electrical circuit, means including a toggle to maintain the switch closed, a circuit current coil, a circuit potential coil, and toggle operating means associated with said coils and operative to open said switch, said operating means including a plurality of armatures having a common yieldable pivot.

13. In a switch control means for an electrical circuit, means including a toggle to maintain the switch closed, a circuit current coil, a circuit potential coil, and toggle operating means asso-

ciated with said coils, and operating to open said circuit when the current and voltage respectively of said coils reaches a predetermined low value, said operating means including a plurality of armatures having a common yieldable pivot.

14. In a disconnecting switch, main contact members, means for actuating said contacts to open position, latch mechanism for maintaining said contact members in closed position against the force of the opening means, and voltage responsive means effective upon energization above a predetermined degree to close and latch the main contacts, and means effective upon de-energization to a predetermined low value of voltage and current to trip said latch mechanism.

15. In a switch apparatus, main contact members, means for biasing said contact members to open position, latch mechanism for restraining said contact members in closed position against the force of said biasing means, electro-magnetic closing means for said contact members and electro-responsive means effective when energized below a predetermined degree to connect said closing means for energization and effective when energized above a predetermined degree to disconnect said closing means and oppose the opening of said latch mechanism.

16. An alternating current tripping mechanism comprising a movable tripping member operable to a tripping position, an electro-magnetic actuating element energized solely in accordance with a potential condition for moving said member to non-tripping position, and a second electro-magnetic element energized in accordance with a current condition for cooperating with the first element for preventing movement of said member to tripping position except upon predetermined current and voltage conditions.

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