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AUTOMATIC TRANSFER SWITCHING SYSTEM

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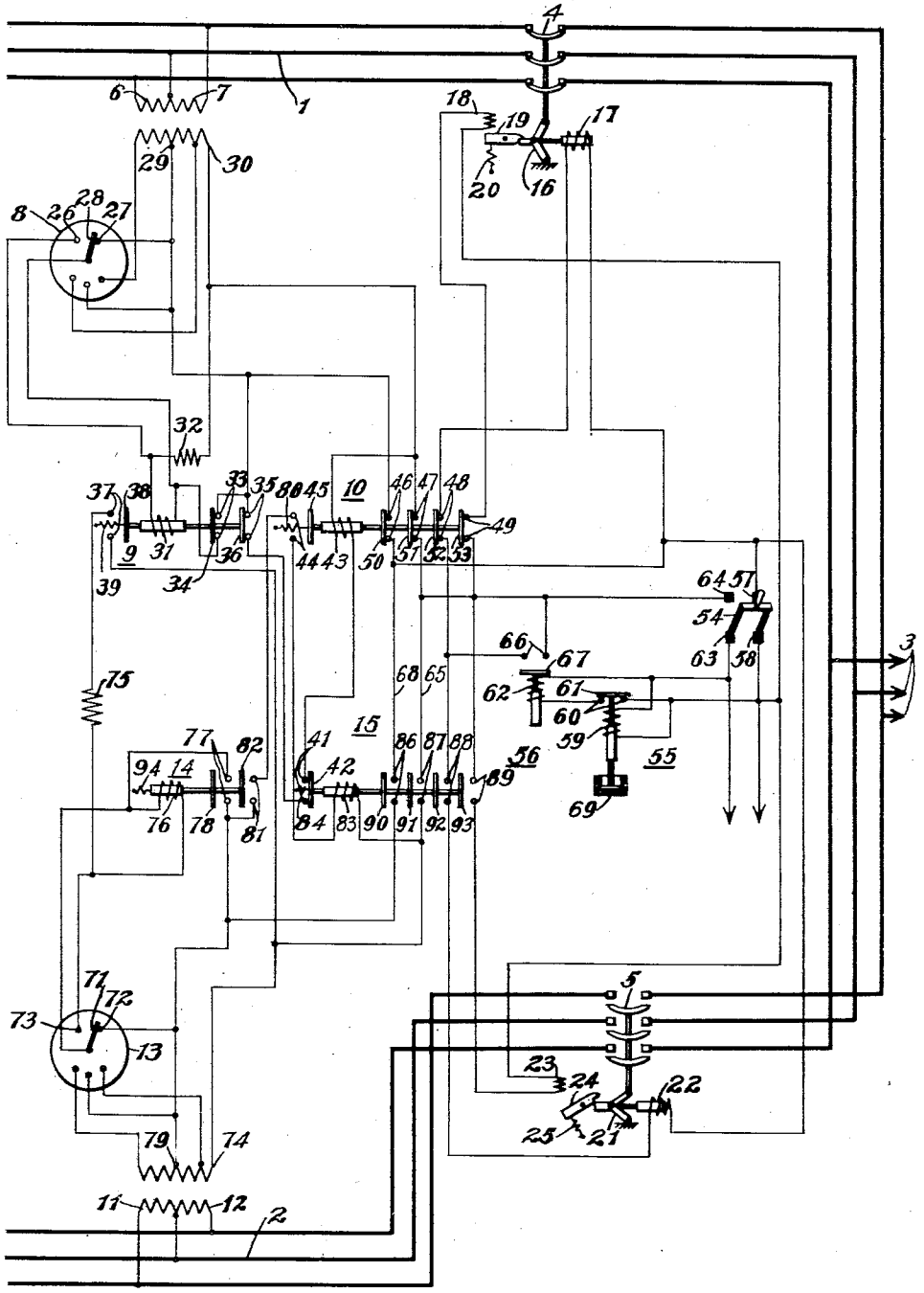

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UNITED STATES PATENT OFFICE.

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AUTOMATIC TRANSFER SWITCHING SYSTEM.

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To all whom it may concern:

Be it known that I, CHARLES A. BUTCHER, a citizen of the United States, and a resident of Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Automatic Transfer Switching Systems, of which the following is a specification.

My invention relates to switching systems and particularly to automatic transfer switching systems for high tension supply circuits.

One object of my invention is to provide means for automatically transferring a substation, or a load, from a preferred source of electromotive force to an auxiliary source when a fault occurs in the preferred source, and for transferring the substation, or the load, back to the preferred source when that source becomes normal.

Another object of my invention is to provide an automatic system embodying means of the above indicated character that shall be simple and economical in construction and reliable in its operation.

In practicing my invention, I provide a phase relay for the preferred source of electromotive force and one for the auxiliary source that shall be energized in accordance with the condition of that circuit. A control relay and a transfer relay are provided for the preferred and for the auxiliary sources and are adapted, when energized by the phase relays, in accordance with the condition of the two supply sources, to actuate the corresponding interrupter of the source that is to supply energy to the substation.

When a fault occurs upon the preferred source of energy, the interrupter of that circuit is opened and the transfer relays are simultaneously energized to close the interrupter of the auxiliary circuit, providing that circuit is normal. When the fault in the preferred circuit is cleared and conditions rendered normal, the phase relay of the preferred circuit effects the opening of the interrupter of the auxiliary circuit and then effects the reclosing of the interrupter of the preferred circuit.

The phase relay that is employed is described in the United States Patent No. 1,344,730, issued to B. H. Smith, June 29, 1920, and assigned to the Westinghouse Electric & Mfg. Co. The construction of the relay forms no part of the present invention and is mentioned merely to identify the relay in order that reference may be had thereto.

The relay is adapted to effect the engagement between a movable and a stationary member to control an external circuit upon the occurrence of a phase failure, a phase reversal in the circuit, or a decrease in the voltage of the circuit below a predetermined value.

In the relay employed in the system embodying my invention, I have provided an additional contact member that is engaged by the movable contact member while the circuit is normal.

The single figure of the accompanying drawing is a diagrammatic view of an electrical circuit embodying my invention.

The system comprises, in general, a preferred source 1 of electromotive force, an auxiliary source 2 of electromotive force, a load circuit 3 that is to be supplied with energy from either of the two sources, and a plurality of circuit interrupters 4 and 5 for respectively connecting the preferred and the auxiliary sources to the load circuit 3.

The preferred circuit 1 is provided with a plurality of potential transformers 6 and 7 that are employed to energize a phase relay 8 in accordance with the condition of the circuit 1. The circuit 1 is further provided with a relay 9 and a transfer relay 10 that are controlled by the relay 8 which controls the actuation of the interrupter 4.

The circuit 2 is similarly provided with a plurality of transformers 11 and 12 that are employed to energize a phase relay 13. The phase relay 13, serves, when properly energized, to control the operation of a relay 14 and a transfer relay 15. The relays 14 and 15 control the actuation of the corresponding interrupter 5 of the auxiliary circuit 2.

The phase relays 8 and 13 are described in the patent mentioned above. So long as conditions are normal in the respective circuits 1 and 2, the relays are stationary. Upon the occurrence of a phase failure, a phase reversal, or a decrease in the voltage of the circuit below a predetermined value, the relays operate to effect the actuation of the corresponding relays 9 or 14, respectively.

The interrupter 4 is provided with an ac-

tuating mechanism 16 that may be operated to close the interrupter through a closing coil 17 and then maintained in that position by the action of a holding coil 18 on a latching member 19. When the holding coil 18 becomes de-energized, a spring 20 releases the mechanism 16 by moving the latching member 19.

The interrupter 5 is similarly provided with an actuating mechanism 21, a closing coil 22, a holding coil 23, a latching member 24 and a spring 25 that operate in the same manner as the corresponding elements of the interrupter 4.

The relay 8 is provided with two stationary contact members 26 and 27 and a movable contact member 28 that normally engages the contact member 27. When a fault occurs in the circuit 1, the contact member 28 is moved over to engage the contact member 26 and it maintains the engagement until the fault is cleared.

While conditions in the circuit 1 are normal, a circuit is completed from the terminal 29 of the secondary winding of the transformer 7 through the contact members 27 and 28 of the relay 8, the operating coil 31 of the relay 9, and a limiting resistor 32 to the other terminal 30 of the secondary winding of the transformer 7.

The coil 31, being thus energized actuates the relay 9 and effects engagement of contact members 33 by a bridging member 34, and of contact members 35 by a bridging member 36. A bridging member 38 is simultaneously disengaged from contact members 37. A spring 39 returns the relay to its initial position when the coil 31 of the relay 9 becomes de-energized.

Upon the actuation of the relay 9, a circuit is completed from the terminal 29 of the transformer 7 through the contact members 33, the bridging member 34, and the winding 31, of the relay 9, and the resistor 32 to the other terminal 30 of the transformer. A holding circuit is thus completed that serves to maintain the relay 9 in its energized position, irrespective of slight fluctuations of the circuit that may effect the disengagement of the contact members 27 and 28 of the relay 8, but that may be insufficient to cause the contact member 28 to engage the contact member 26.

When the relay 9 is actuated, a second circuit is simultaneously completed from the terminal 29 of the transformer 7 through the contact members 35 and the bridging member 36 of the relay 9, a plurality of contact members 41 and the bridging member 42 of the relay 15, the operating coil 43 of the relay 10 to the terminal 30 of the transformer 7.

The coil 43 is thereupon energized and actuates the relay 10, causing the disengagement of a plurality of contact members 44 by a bridging member 45 and effecting the engagement of four sets of contact members 46, 47, 48 and 49 by corresponding bridging members 50, 51, 52 and 53.

Upon the actuation of the relay 10, a plurality of circuits are completed through a two-pole single throw manually operated switch 54 and two relays 55 and 56 for respectively energizing the closing coil 17 and the holding coil 18 of the interrupter 4. Upon the operation of the relay 10, the operating coils of the above relays 55 and 56 become energized. Relay 56 serves to energize the closing coil of the interrupter that is to be actuated. Relay 55 serves to open the circuit of the operating coil of the relay 56 after a predetermined interval of time that is normally sufficient to permit the closing of the interrupter.

Upon the actuation of the relay 10, a circuit is completed from the terminal 29 of the transformer 7 through the contact members 46 and the bridging member 50 of the relay 10, the jaw and the blade members 57 and 58 of the switch 54, thence through two parallel circuits, one of which includes the operating coil 59 of the relay 55, and the other of which includes the contact members 60 and the bridging member 61 of the relay 55 and the operating coil 62 of the relay 56, thence through the jaw and the blade members 63 and 64 of the switch 54 and the contact members 47 and the bridging member 51 of the relay 10 to the terminal 30 of the transformer 7.

The relay 56 is thereupon actuated to complete a circuit from a control bus conductor 65 through the contact members 66 and the bridging members 67 of the relay 56, the contact members 48 and the bridging member 52 of the relay 10, the closing coil 17 of the interrupter 4 to the other control bus conductor 68. The closing coil 17 is thereupon energized to close the interrupter 4.

The control bus conductors 65 and 68 are adapted to be connected to the terminals of the secondary windings of the potential transformers 7 or 12 dependent upon whether the relay 10 or 15 is closed.

The relay 55, that has meanwhile been energized, effects the disengagement of its contact members 60 by the bridging member 61 after an interval of time that is determined by the setting of the dash pot 69. The circuit of the operating coil 62 of the relay 56 is thereupon opened and the circuit of the closing coil 17 of the interrupter 4, consequently, is also opened. The relay 55 remains energized to prevent re-energization of the closing coil of the interrupter 4, so long as conditions in the circuit 1 remain normal.

Simultaneously with the energization of the closing coil of the interrupter 4, a cir-

cuit was completed from the bus conductor 65 through the contact members 49 and the bridging member 53 of the relay 10, the holding coil 18 of the interrupter 4, the blade and the jaw members 58 and 57 of the switch 54 to the control bus conductor 68, thereupon energizing the holding coil 18.

The holding coil 18 remains energized as long as conditions in the circuit 1 remain normal and the switch 54 remains closed. To open the interrupter 4 after it has been closed, it is necessary merely to open the switch 54 which will thereupon open the circuit of the holding coil 18 and permit the interrupter 4 to open.

Upon the occurence of a fault in the circuit 1 that will be sufficient to operate the relay 8 to effect engagement between the contact members 28 and 26, the coil 31 of the relay 9 will be short-circuited by the contact members 28 and 26 and the consequent de-energization of the coil 31 will permit the spring 39 to reset the relay 9 which will cause the bridging members 34 and 36 to disengage the corresponding contact members 33 and 35.

Upon the return of the relay 9 to its initial position, engagement is effected between the contact members 37 and the bridging member 38 of the relay. If the condition of the auxiliary circuit 2 is normal, a circuit will be completed through the members 37 and 38 of the relay 9 and two contact members 71 and 72 of the relay 13, which will be engaged. If a fault obtains on the circuit 2, however, such as to cause abnormal conditions therein, the contact member 71, which is movable, will be caused to engage a stationary contact member 73.

Assuming the conditions of the auxiliary circuits 2 to be normal, a circuit will be completed upon the return of the relay 9 to its initial position from the terminal 74 of the transformer 12 through the contact members 37 and the bridging member 38 of the relay 9, a resistor 75, the operating coil 76 of the relay 14, and the contact members 71 and 72 of the relay 13 to the other terminal 79 of the transformer 12.

The operating coil 76 thereupon becomes energized and operates the relay 14. Upon the actuation of the relay 14, engagement is effected between a plurality of contact members 77 and a bridging member 78 of the relay 14, that are connected in parallel relation to the contact members 71 and 72 of the relay 13. A circuit is then completed through the contact members 77 and the bridging member 78 that serves as a holding circuit for the relay 14.

When the relay 9 is de-energized and returned to its initial position, the energizing circuit of the holding coil 43 of the relay 10 is opened by the disengagement of the contacts 35 by the bridging member 36 of the relay 9, thus permitting the relay 10 to be returned to its initial position by a spring 80.

Upon the return of the relay 10 to its initial position, engagement is effected between the contact members 44 and the bridging member 45 thereof. The contact members 46, 47, 48 and 49 are simultaneously disengaged by the corresponding bridging members 50, 51, 52 and 53.

The relay 14 then serves to complete a circuit, for operating the relay 15, from the terminal 79 of the transformer 12 through a plurality of contact members 81 and a bridging member 82, the contact members 44 and the bridging member 45 of the relay 10, and the operating coil 83 of the relay 15 to the other terminal 74 of the transformer 12.

The operating coil 83, upon being energized, actuates the relay 15 against the force of the spring 84 to effect disengagement of the contact members 41 and the bridging member 42. Simultaneously, engagement is effected between four sets of contact members 86, 87, 88 and 89 and the corresponding bridging members 90, 91, 92 and 93, respectively.

Upon the actuation of the relay 15, voltage is impressed, by the transformer 12, on the control bus conductors 65 and 68 through the contact members 87 and 86 and the corresponding bridging members 91 and 90. The closing of the interrupter 5 is thereupon effected in a manner similar to that explained above in connection with the interrupter 4.

It will be observed that the interrupter 5 may also be opened by opening the switch 54 since the circuit of the holding coil 23 of the interrupter 5 is opened by that operation.

The load circuit 3 has thus been connected to the preferred circuit 1 while that circuit has been normal; it has been disconnected from that circuit upon the occurrence of a fault therein and has been immediately connected to the auxiliary circuit 2, to which it will remain connected until the circuit 1 again becomes normal.

When conditions in the preferred circuit 1 again become normal, the relay 8 becomes so energized as to effect reengagement between the contact members 27 and 28 thereof. The operating coil 31 of the relay 9 thereupon becomes re-energized, and, by effecting the disengagement of the contact members 37 and the bridging member 38, serves to de-energize the coil 76 of the relay 14.

The relay 14 is thereupon returned to its initial position by its spring 94. The consequent disengagement of the contact members 81 and the bridging member 82 opens the

circuit of the operating coil 83 of the relay 15, thereby permitting that relay to be returned to its initial position by its spring 84.

The consequent re-engagement of the contact members 41 and the bridging member 42 of the relay 15 completes the circuit that serves to energize the operating coil 43 of the relay 10.

Upon the return of the relay 15 to its initial position and the consequent disengagement of the contact members of that relay and the corresponding bridging members, the holding coil 23 of the interrupter 5 becomes deenergized and the interrupter 5 is permitted to open.

Simultaneously, the operation of the relay 10 recompletes the operating circuits that effect the reclosing of the interrupter 4.

It will thus be observed that the preferred circuit remains connected to the load circuit so long as conditions remain normal in the preferred circuit, but, upon the occurrence of a fault in the preferred circuit, the load circuit is automatically disconnected therefrom and transferred to the auxiliary circuit. Also, upon the return of normal conditions in the preferred circuit, the load circuit is disconnected from the auxiliary circuit and reconnected to the preferred circuit.

If, while the preferred circuit is faulty, a fault should occur on the auxiliary circuit, the relay 13 would effect engagement of the contact members 71 and 73 thereof and deenergize the operating coil 76 of the relay 14 by short-circuiting that coil. The relay 15 would thereupon be returned to its initial position by reason of the deenergization of its holding coil 83 and the interrupter 5 would be opened. Both interrupters 4 and 5 would then remain open until the fault was cleared on either circuit 1 or 2. The corresponding interrupter would then be reclosed.

Although I have shown a preferred system embodying my invention, I do not limit the system to the specific devices that are illustrated therein, nor to the specific arrangement of those devices, as various modifications may be made therein without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim as my invention:

1. In an electrical distribution system, the combination with a preferred and a second source of polyphase electromotive force, and circuit interrupters between said sources and a load section of the system, of means for switching the load section of the system from the preferred source to the second source upon the occurrence of a fault on the preferred source and for switching the section back to the preferred source when that source becomes normal again, comprising means responsive to the phase and voltage conditions of the two sources of electromotive force.

2. In an electrical distribution system, the combination with a preferred and a second source of polyphase electromotive force, and circuit interrupters between said sources and a load section of the system, of means responsive to phase and voltage conditions of the preferred source, switching means controlled thereby for switching the load section to the second source upon the occurrence of a fault on the preferred source affecting the normal phase or voltage conditions, and means for switching the section back to the preferred source upon the clearing of the fault.

3. In an electrical distribution system, the combination with a preferred and an auxiliary source of polyphase electromotive force, and circuit interrupters between said sources and a load section of the system, of means responsive to phase and voltage conditions of the preferred source, means controlled thereby for rendering the preferred interrupter inoperative, means controlled by said controlled means for rendering the auxiliary interrupter operative upon the occurrence of abnormal conditions in the preferred source of electromotive force, said last means being rendered inoperative by the condition responsive means of the preferred source when the abnormal condition clears and conditions in the preferred source return to normal.

4. In an electrical distribution system, the combination with a preferred and a second source of polyphase electromotive force, and circuit interrupters between said sources and a load section of the system, of means responsive to the phase and voltage conditions of the preferred source, means controlled thereby for rendering the preferred interrupter inoperative and for rendering the second interrupter operative, and means responsive to the phase and voltage conditions of the second source for controlling the operation of the interrupter associated with that source.

5. In an electrical distribution system, the combination with a preferred and a second source of polyphase electromotive force, and circuit interrupters between said sources and a load section of the system, of means responsive to the phase and voltage conditions of the preferred source, means controlled thereby for rendering the preferred interrupter inoperative and for rendering the second interrupter operative, and means responsive to the condition of the second source for preventing the actuation of the second interrupter if an abnormal condition obtains on the second source simultaneously with an abnormal condition on the preferred source.

6. In a power-distributing system, the

combination with a load section of the system that is to be maintained energized and a plurality of sources of energy for supplying energy thereto in a preferred sequence, of means severally responsive to the conditions of the respective sources, control devices controlled by said means in accordance with the condition of the associated source, means for permitting the operation of only one of said control devices at one time, connecting means between the load section and the respective sources of energy, means comprising a single operating unit for controlling the operation of the several connecting means, and means associated with each source for providing control energy from the associated source to the operating unit for controlling the respective connecting means.

7. In an electrical distribution system, the combination with a preferred and an auxiliary source of electromotive force, and circuit interrupters between said sources and a load section of the system, of actuating means for the interrupters, means for energizing the actuating means, means for controlling the effectiveness of the energizing means, and means responsive to electrical conditions in the respective sources of electromotive force for controlling the controlling means.

8. In an electrical distribution system, the combination with a preferred and an auxiliary source of electromotive force and circuit interrupters between said sources and a load section of the system, of actuating means for the circuit interrupters, means for deriving a control voltage from each source of electromotive force, switching means for subjecting the actuating means of the interrupters to the corresponding control voltage, and means responsive to the electrical condition of the respective sources of electromotive force for controlling the actuation of the corresponding switching means.

9. In an electrical distribution system, the combination with a preferred and an auxiliary source of electromotive force, and circuit interrupters between said sources and a load section of the system, of means responsive to the condition of the preferred source, a relay controlled by said means and normally maintained in its energized position, means controlled by the relay for effecting the closing of the preferred interrupter and for maintaining the same closed, a second relay energized when the former relay is released upon the occurrence of abnormal conditions in the preferred circuit, and means controlled by the latter relay for effecting the closing of the auxiliary interrupter and for maintaining the same closed until conditions in the preferred circuit return to normal.

10. In an electrical distribution system, the combination with a preferred and an auxiliary supply source of electromotive force, and a circuit interrupter between each source and a load section of the system, of means responsive to the condition of each supply source, a control relay for each supply source, and a transfer relay for each supply source controlled by the corresponding control relay to transfer an energizing control circuit from the associated source to actuate the corresponding interrupter.

11. In an electrical distribution system, the combination with a preferred and an auxiliary supply source of electromotive force, and a circuit interrupter between each source and a load section of the system, of means responsive to the condition of each supply source, and a transfer relay for each supply source that is controlled by the responsive means to effect the actuation of the corresponding interrupter.

12. In an electrical distribution system, the combination with a preferred and an auxiliary source of polyphase electromotive force, and circuit interrupters between said sources and a load section of the system, of means for switching the load section of the system from the preferred source to the auxiliary source upon the occurrence of a phase failure or phase reversal on the preferred source and for switching the section back to the preferred source when that source becomes normal again.

13. In an electrical distribution system, the combination with a preferred and an auxiliary source of polyphase electromotive force, and circuit interrupters between said sources and a load section of the system, of means responsive to the effect produced by a phase failure, phase reversal, and drop in voltage on the preferred source, means controlled thereby for rendering the preferred interrupter inoperative and for rendering the auxiliary interrupter operative, and means responsive to the condition of the auxiliary source for controlling the operation of the interrupter associated with that source.

In testimony whereof, I have hereunto subscribed my name this 23rd day of December, 1920.

CHARLES A. BUTCHER.