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SYSTEM OF ELECTRICAL DISTRIBUTION.

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Fig. 1.

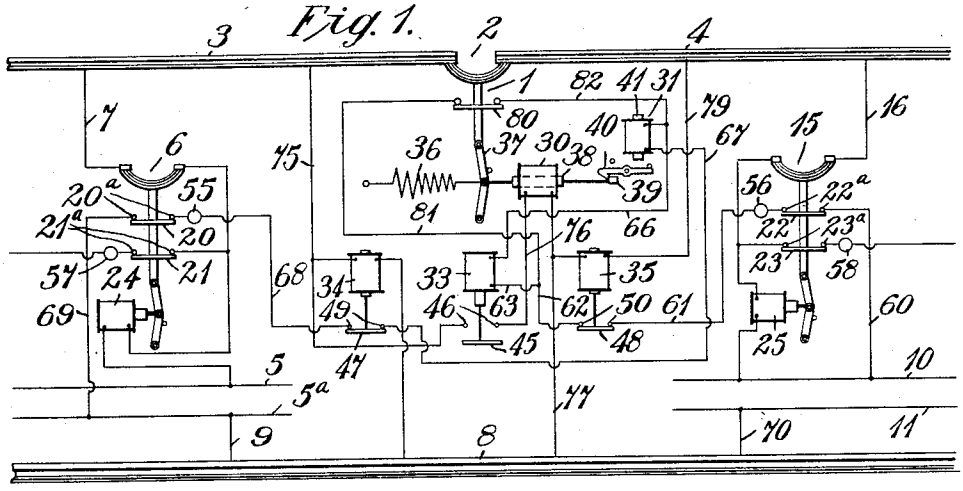
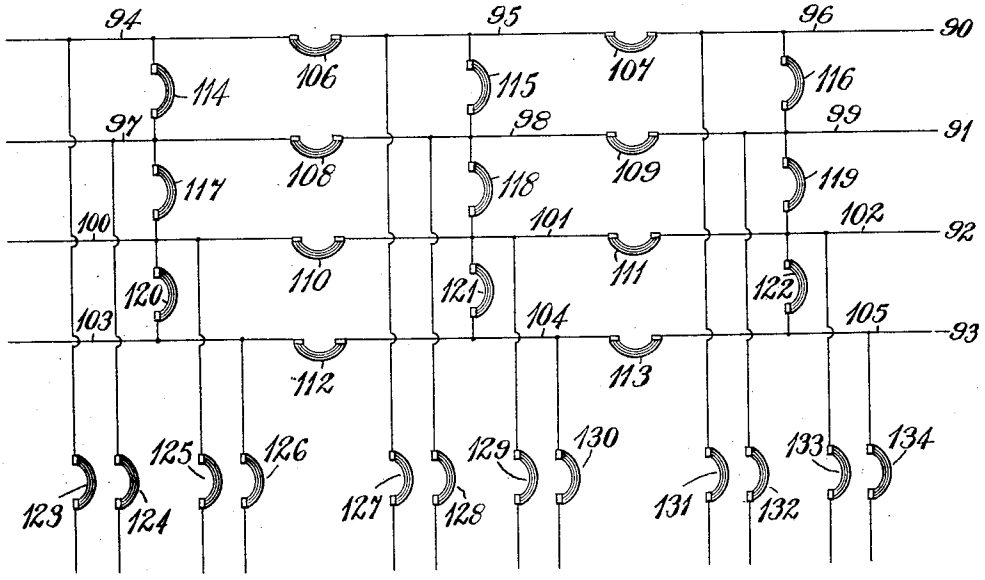


Fig. 2.



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SYSTEM OF ELECTRICAL DISTRIBUTION.

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To all whom it may concern:

Be it known that I, FORD W. HARRIS, 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 Systems of Electrical Distribution, of which the following is a specification.

My invention relates to systems of electrical distribution and it has special reference to systems which are adapted to supply power to the trolley wires or third rails of electric railway systems.

The object of my invention is to provide means for automatically cutting out a section of a trolley wire or third rail circuit in case of a ground, short-circuit or other abnormal disturbance and to provide further means for automatically re-connecting said section when the normal circuit conditions are reëstablished.

Electric railway systems generally comprise a plurality of sections, each of which is provided with an individual supply feeder, in order that trouble on the line may be localized without tying up the traffic of the whole system. At each section break, it is customary to employ some form of switch or tie-in breaker which, when closed, ties the sections into one continuous line in order to make use of the full conductivity of all the copper available. This practice is especially desirable in a two or four track railway system, such as elevated or subway systems in large cities and tunnel or terminal electrifications of steam roads.

In systems of the above mentioned classes, very large amounts of power are required, and economy demands that, not only shall the several sections of each third rail be tied together, but the sections of adjacent rails shall be interconnected as well. According to my invention, the tie-in breakers of each section are so connected that, in the event of a short-circuit or low-voltage on any particular section, all the tie-in breakers of that section open simultaneously to segregate it from the rest of the system until repairs are made or normal circuit conditions restored.

Another feature of my invention provides that the interlocking auxiliary circuit connections of the several tie-in breakers of each section shall be so arranged that these breakers will not close to re-connect the dead section until the voltage of said section is approximately equal to the full voltage of the adjacent sections with which it is to be connected, and until the closure of the feeder breakers of the dead section and of the adjacent sections has been effected.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is a diagrammatic view of the main and auxiliary circuits of a portion of two adjoining sections of a single track third rail system of electric railways, and Fig. 2 is a diagrammatic view of the main circuits and interconnecting breakers of a four track third rail system of distribution to which my invention is readily applicable.

It will be understood that, while the accompanying drawings are illustrative of third rail installations for direct currents, the usual trolley construction lends itself equally well to similar adaptation and that alternating current systems also may readily be equipped with the distribution system of my invention.

Referring to Fig. 1 of the accompanying drawings, a tie-in breaker 1 is adapted to bridge a section break 2 between adjoining sections 3 and 4 of a third rail railway installation. The section 3 is supplied with energy from a source 5—5ª, the positive bus-bar 5 being connected to the section 3 by means of an overload circuit-breaker 6 and a feeder cable 7, while the negative bus-bar 5ª is grounded to the track rails 8 (only one of which is shown) by means of a conductor 9. A positive bus-bar 10 of a source of energy 10—11 is similarly connected to third rail section 4 by means of an overload circuit breaker 15 and a feeder cable 16. Although two separate sources of energy are illustrated in the drawing, it is evident that the several sections may be fed from the same source through independent feeders.

The overload breakers 6 and 15 may be located in the generating station and operated by hand or they may, and probably will, be situated at points on the system that are remote from the generating station, in which case, said breakers will be equipped with electrically operated resetting devices and an auxiliary remote-control system. Feeder breakers 6 and 15 are provided, respectively, with auxiliary switch members 20, 21 and 22, 23 which are adapted to bridge

contact terminals 20^a, 21^a and 22^a, 23^a, and with overload trip coils 24 and 25. These breakers may, of course, be of any well known construction and may be provided with suitable resetting mechanisms (not shown).

The tie-in breaker 1 is provided with a closing coil 30, a no-voltage trip coil 31, a relay coil 33 and two low-voltage relay coils 34 and 35. When energized, the closing coil 30 acts against the tension of a spring 36 and, by means of a toggle 37, closes the breaker. A movable core 38 of the closing coil 30 is provided with a retaining catch 39 which is adapted to be engaged by a latch 40 when the breaker is closed. Under normal operating conditions, the no-voltage trip coil 31 is energized, but if, in the accordance with predetermined conditions of the system, the energizing circuit is broken, its coil 41 is allowed to drop and thus disengage the latch 40 from the retaining catch 39 and allowing the spring 36 to release the breaker.

The armature of the relay coil 33 is provided with a switch member 45 which is adapted to bridge stationary contact terminals 46 to establish connections through the closing coil 30.

The armatures of the low-voltage relay coils 34 and 35 are respectively provided with switch members 47 and 48 which bridge contact terminals 49 and 50 to complete the main interlocking circuit through the no-voltage trip coil 31, and said relays are designed and constructed to release at a predetermined low voltage of about 250 volts and to pick up at a higher predetermined voltage of about 450 volts. Relay coil 34 is connected to section 3, and relay coil 35 is similarly connected to section 4 of the third rail. To indicate the position of the tie-in breaker 1, tell-tale lamps 55 and 56 are connected in series with the control circuit of the no-voltage trip coil 31 and are lighted only when the circuit breaker is closed. A lamp 57 performs a similar function for the adjacent breaker (not shown) at the remote end of section 3, while a lamp 58 indicates the position of the adjoining breaker (not shown) at the further end of section 4.

The operation of the system thus far described is as follows: Assuming that the arrangement of connections is as shown in Fig. 1 and that the feeder breaker 15 is opened, either manually or automatically, the switch member 22 is disengaged from its contact terminals 22^a and breaks the circuit from the positive bus-bar 10 through conductor 60, switch member 22, tell-tale lamp 56, conductor 61, switch member 48, conductor 62, conductor 81, switch member 80, conductor 82, no-voltage trip coil 31, conductor 67, switch member 47, conductor 68, tell-tale lamp 55, switch member 20, of the feeder breaker 6, conductor 69, negative bus-bar 5^a, conductor 9, track rail 8, and conductor 70 to the negative bus-bar 11. Upon the interruption of this circuit, no-voltage trip coil 31 is deënergized and the core 41 drops, thereby withdrawing the latch 40 and allowing the breaker to open, as hereinbefore explained. It will be observed that, as breaker 15 is opened, the circuit through the switch member 23 and contact terminals 23^a is likewise broken, thus causing the adjacent tie-in circuit breaker (not shown) to be released, in a similar manner, to cut section 4 out of the system. The low-voltage relay coil 35 then becomes deënergized and switch member 48 becomes disengaged from contact terminals 50. As feeder breaker 15 is again closed, voltage is supplied to section 4 and, if the voltage exceeds 450 volts, the low-voltage relay coil 35 causes the switch 48 to engage contact terminals 50. Switch members 22 and 23 of the feeder breaker 15 likewise bridge the contact terminals 22^a and 23^a, and switch member 22 completes the circuit from the positive bus-bar 10 through conductor 60, switch member 22, lamp 56, conductor 61, switch member 48, conductor 62, conductor 63, relay coil 33, conductor 66, trip coil 31, conductor 67, switch member 47, conductor 68, lamp 55, switch member 20, conductor 69, negative bus-bar 5^a, conductor 9, track rails 8 and conductor 70 to the negative bus-bar 11. The circuit thus established energizes the no-voltage trip coil 31 which raises the core 41 from the latch 40, and, at the same time, energizes the relay coil 33 and causes it to complete a circuit from third rail section 3 through conductor 75, switch member 45, conductor 76, closing coil 30 and conductor 77 to the track rail 8. The closing coil 30 becomes energized and exerts such pull against the spring 36 as to close the breaker 1, while the latch 40 engages the retaining catch 39 and holds the breaker in its closed position. It will be observed that, as the breaker 1 is closed, auxiliary switch member 80, which is associated with it, completes a circuit through conductor 81, switch member 80 and conductor 82, which short-circuits the relay coil 33 and causes it to be deënergized. The circuit through the closing coil 30 is thereby interrupted and the breaker is maintained in its closed position entirely through the action of the latch 40, the closing coil 30 remaining in circuit only momentarily while the breaker is being closed. In order that the tell-tale lamps 55 and 56 shall not indicate a false position of the breaker, the relay coil 33 is of high-resistance which prevents the lamps from lighting until it is short-circuited by the closure of the breaker.

Again assuming the apparatus to occupy the positions shown in Fig. 1, the effect of

a ground on section 4 is as follows: Upon the occurrence of a ground, the voltage falls on section 4 and neighboring sections and, if said voltage drops below 250 volts, all the low-voltage relays connected to the point of low voltage are opened, thus interrupting the circuits of the no-voltage trip coils of the tie-in breakers and causing said breakers to open, thereby dividing the third rail up into its component sections. The ground is then confined to section 4 and, as the voltage of the remaining sections rises to its normal value, they are automatically reconnected, leaving section 4 segregated from the rest of the system.

It is evident that, if the voltage of section 4 remains below 450 volts, the low-voltage relay coil 35 will not pick up, but, if the rail clears, the voltage rises to its normal value and the tie-in breakers are again closed by the action of the low-voltage relays. Should the ground be of a serious nature, it is possible that the excess of current drawn through the feeder 16 would be sufficient to cause the overload coil 25 to open the feeder breaker.

In case of a heavy overload or short-circuit on any section, the resulting low voltage will cause the tie-in breakers in that part of the system to be opened, but, on account of the multiplicity of feeders, it is probable that the feeder breakers will remain closed by reason of the fact that the load is distributed among several feeders.

It is thus possible for the system to be broken up into sections by a general opening of the tie-in breakers and be immediately reconnected by these breakers, with the exception of such as are directly associated with the section upon which the short-circuit occurs. The short-circuit is thus confined to a single section and the feeder breaker of that section is therefore opened. It is, of course, possible that such a short circuit might be severe enough to cause a general opening of the feeder breakers of the adjoining sections, in which case, the operator at the generating station may cause all the feeder breakers to be again closed, with the exception of that particular breaker directly associated with the disabled section.

Referring now to Fig. 2, the four third rails 90, 91, 92 and 93 are divided up into independent sections 94 to 105 inclusive. The adjoining sections of the several rails are tied together by the breakers 106 to 113, inclusive, while the adjacent sections are interconnected by means of breakers 114 to 122 inclusive: Feeder breakers 123 to 134 inclusive are connected in the feeders which individually supply the sections 94 to 105 with power from a source of energy (not shown). In the system illustrated, in order to segregate any one section, it is necessary to open either three or four tie-in breakers instead of two, as in the system hereinbefore described, which necessitates that each feeder breaker shall be provided with three or four switch members, as will be hereinafter noted. For example: If section 98 is to be segregated, the control circuits of tie-in breakers 108, 115, 109 and 118 must be interlocked with the switch member of feeder breaker 128. In a similar manner, if section 95 is to be cut out of circuit, the tie-in breakers 106, 107 and 115 must be rendered dependent upon the action of feeder breaker 127.

It is not considered necessary to describe further the application of my invention to the system illustrated in Fig. 2, on account of its similarity to the system fully described with respect to Fig. 1, and the ease with which those skilled in the art can readily understand the adaptability of my invention to the system shown.

Although I have described and illustrated a specific arrangement of connections, I desire that modifications and variations may be effected which do not depart from the spirit and scope of my invention, and I further desire that only such limitations shall be imposed as are indicated in the appended claims.

I claim as my invention:

1. In a system of electrical distribution, the combination with a source of energy, a system of feeders, and a distributing circuit comprising a plurality of independent sections and a plurality of circuit breakers severally connecting adjacent sections under normal operating conditions, of electro-responsive means coöperating with said feeders and said sections in common and dependent upon an abnormal current demand and predetermined low-voltage conditions, and means associated with and dependent upon the electro-responsive means for segregating any section from the rest of the system.

2. The combination with a source of energy, a distributing circuit comprising a plurality of sections, independent feeders for supplying said sections with energy, overload circuit breakers for said feeders and a plurality of electrically operated tie-in circuit breakers provided with no-voltage release mechanisms and adapted to bridge the section breaks, of means dependent upon abnormal current demand for cutting out any section, means dependent upon a predetermined low-voltage for opening all tie-in breakers affected by such voltage, and means for automatically closing said tie-in breakers only when the voltages on the sections to be connected are of substantially normal value and the feeder breakers of said sections are closed.

3. In a system of electrical distribution, the combination with a source of energy, a

distributing circuit comprising a plurality of independent sections, independent feeders for the respective sections, overload circuit breakers for said feeders, and a plurality of electrically operated tie-in circuit breakers adapted to bridge the breaks between the several sections, of a single control circuit for each tie-in breaker interlocked with the feeder breakers of the adjoining sections and two low-voltage relays, one connected to each adjoining section, an auxiliary relay associated with the closing coil of the breaker and adapted to be energized by said control circuit under predetermined conditions, and a no-voltage trip coil adapted to release the breaker when the aforesaid control circuit is interrupted.

4. In a system of electrical distribution, the combination with a source of energy, a feeder system, a distributing circuit comprising a plurality of independent sections, and a plurality of electrically operated circuit breakers adapted to interconnect adjoining sections, of an indicating lamp and a high resistance auxiliary relay associated with each circuit breaker and adapted to establish a circuit through the closing coil of said breaker, and an auxiliary switch member associated with said breaker and adapted to short-circuit the auxiliary relay when the breaker is closed.

5. In a system of electrical distribution, the combination with a source of energy, a feeder system, a distributing circuit comprising a plurality of independent sections, and a plurality of circuit breakers severally provided with no-voltage trip coils and adapted to interconnect said sections, of a single energizing circuit for each trip coil which is interlocked with the feeder circuit breakers of the adjoining sections and a low-voltage relay associated with each adjoining section.

6. In a system of electrical distribution, the combination with a source of energy, a distributing circuit comprising a plurality of independent sections, separate feeders for said sections and overload circuit breakers therefor, of a plurality of tie-in circuit breakers adapted to bridge the respective section breaks and each provided with an electrically operated closing device, a single control circuit for said closing device, low-voltage relays connected to adjoining sections, an auxiliary switch member associated with each adjoining feeder breaker and a no-voltage trip coil in series with the aforesaid switch members.

7. In a system of electrical distribution, the combination with a source of energy, a distributing circuit comprising a plurality of sections, and a plurality of tie-in circuit breakers adapted to interconnect said sections under normal operating conditions, of a single control circuit associated with each tie-in circuit breaker, and relays and switching devices normally in circuit with said control circuit and adapted to interrupt said circuit under predetermined conditions of low-voltage or abnormal current, and means for releasing said tie-in breaker when said circuit is interrupted.

8. In a system of electrical distribution, the combination with a source of energy, a distributing circuit comprising a plurality of independent sections, separate feeders, overload circuit breakers between the respective sections and their feeders, and a plurality of tie-in circuit breakers adapted to bridge the respective section breaks, of a plurality of switch members associated with each feeder breaker through which the control circuits of the tie-in breakers are separately completed, two low-voltage relays, one connected to each adjoining section and provided with switch members connected in series with the switch members of the adjoining feeder breakers, and a no-voltage trip coil energized by the aforesaid control circuit and adapted to open the tie-in breaker if said circuit is interrupted.

9. In a system of electrical distribution, the combination with a source of energy, a system of feeders, a distributing circuit comprising a plurality of independent sections and a plurality of circuit breakers severally connecting adjacent sections under normal operating conditions, of means associated with said feeders and dependent upon the current therein for concurrently opening certain circuit breakers, and means dependent upon the voltage conditions of any section for concurrently opening certain circuit breakers.

10. In a system of electrical distribution, the combination with a source of energy, a system of feeders, a distributing circuit comprising a plurality of independent sections and a plurality of circuit breakers severally connecting adjacent sections under normal operating conditions, of electro-responsive devices associated with said sections and said feeders and means coöperating with all of said devices for opening certain circuit breakers under predetermined abnormal circuit conditions.

11. In a system of electrical distribution, the combination with a source of energy, a system of feeders, a distributing circuit comprising a plurality of independent sections and a plurality of circuit breakers severally connecting adjacent sections under normal operating conditions, of a plurality of relays dependent upon abnormal current and voltage conditions, and means associated with said relays for concurrently opening certain circuit breakers and segregating any section from the rest of the system.

12. In a system of electrical distribution, the combination with a source of energy, a

system of feeders, a distributing circuit comprising a plurality of independent sections and a plurality of circuit breakers severally connecting adjacent sections under normal operating conditions, of electro-responsive means dependent upon abnormal current and voltage conditions, means associated with said electro-responsive means for concurrently opening certain circuit breakers and segregating any section from the rest of the system, and means coöperating with said electro-responsive means for automatically reconnecting said section to the system when normal circuit conditions are restored.

13. In a system of electrical distribution, the combination with a source of energy, a distributing circuit comprising a plurality of independent sections, a plurality of feeders severally supplying energy to the said sections, and a plurality of circuit breakers connecting adjacent sections under normal conditions, of means associated with each feeder for effecting a concurrent opening of all of the circuit breakers associated with its section of the distributing circuit under predetermined abnormal circuit conditions.

14. In a system of electrical distribution, the combination with a source of energy, a distributing circuit comprising a plurality of independent sections, a plurality of feeders severally supplying energy to the said sections, and a plurality of circuit breakers connecting adjacent sections under normal conditions, of a relay associated with each feeder, and trip coils associated with the said relays for effecting a concurrent opening of all of the circuit breakers associated with its section of the distributing circuit under predetermined abnormal circuit conditions, and means coöperating with said relays and trip coils for automatically closing said circuit breakers when normal circuit conditions are reëstablished.

15. In a system of electrical distribution, the combination with a source of energy, a distributing circuit comprising a plurality of independent sections, a plurality of feeders severally supplying energy to the said sections, and a plurality of circuit breakers connecting adjacent sections under normal conditions, of an overload circuit breaker for each feeder and means associated therewith and with all the circuit breakers connected to the section of the distributing circuit which it supplies, for segregating said section from rest of the system under predetermined circuit conditions.

In testimony whereof, I have hereunto subscribed my name this 3rd day of May, 1910.

FORD W. HARRIS.

Witnesses:
W. L. WRIGHT,
B. B. HINES.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."