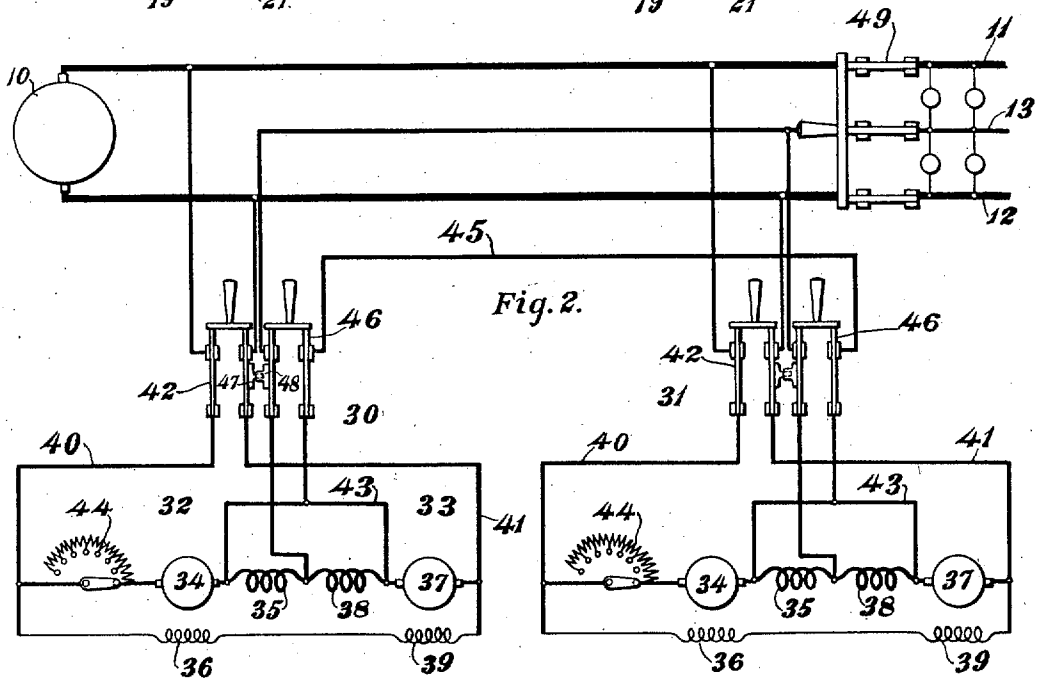
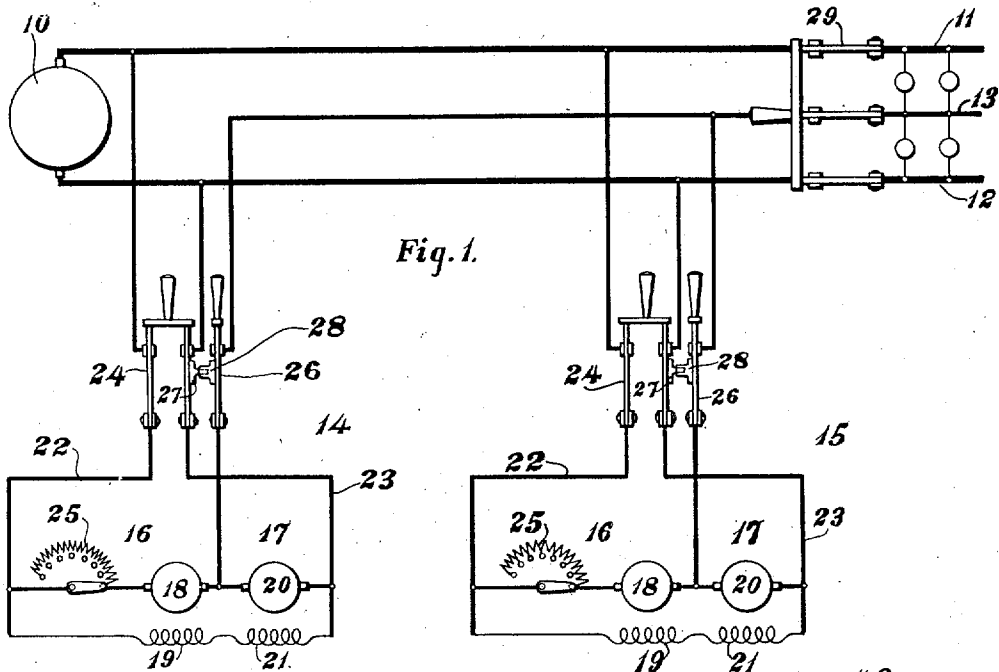


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B. FRANKENFIELD.
SYSTEM OF DISTRIBUTION.
APPLICATION FILED MAR. 31, 1906.



WITNESSES

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SYSTEM OF DISTRIBUTION.

No. 850,218.

Specification of Letters Patent.

Patented April 16, 1907.

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To all whom it may concern:

Be it known that I, BUDD FRANKENFIELD, a citizen of the United States, residing at Norwood, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Systems of Distribution, of which the following is a full, clear, and exact specification.

My invention relates to multiple-voltage systems of distribution in which balancers are employed for maintaining the voltages between the several conductors at their predetermined values when the loads are unbalanced or are unequal.

The size and number of balancers employed in a system depends upon the degree or extent of unbalancing. If at all times the loads are only slightly unbalanced or if the degree of unbalancing is considerable, but does not vary greatly at different times, a single balancer can usually be employed with sufficient economy to maintain the necessary balance of voltage. If, however, the degree of unbalancing of the loads is excessive or if the unbalancing varies greatly at different times, it may be necessary or more economical to employ two or more balancers of the same size or of different sizes in the same system. In the latter case when the loads are only slightly unbalanced a single balancer is connected to the system, the other balancer or balancers remaining idle. When, however, the unbalanced load becomes so great that a single balancer cannot with economy supply sufficient power to maintain the voltages between the conductors at their proper values, two or more balancers are connected in parallel to the system.

Each balancer is usually equipped with at least two switches for connecting it to or disconnecting it from the main source of power and the multiple-voltage system. One of the switches, usually a double-pole switch, is located in the conductors connecting the balancer to two outer or main conductors or legs of the system, and the other switch is in the neutral or compensating conductor. The balancer is also provided in the armature-circuit with a rheostat or starting-box for bringing the balancer to the proper speed before it is connected to the neutral or compen-

sating conductor or before it is ready to "take load." To start a balancer, the double-pole switch in the outer or main conductors is first closed, and the balancer is brought up to speed by gradually cutting out the resistance of the starting-box. When the balancer is up to speed, the switch in the neutral or compensating conductor is closed. A multipole switch or circuit-breaker (the number of poles depending on the number of conductors of the multiple-voltage system) is provided between the lamps or other translating devices constituting the load for connecting the latter to the main source of current and to the balancer.

When there is only a single balancer employed in the system, no damage can result to the balancer or translating devices in case the switch in the neutral or compensating conductor is closed before the balancer is brought up to speed, providing the multipole load-switch is not closed until the balancer is up to speed.

In case two or more balancers are adapted to be employed in the same system if it is desired to connect an idle balancer in parallel to a balancer already in operation with the apparatus formerly employed and as balancers have heretofore been connected, there is danger of a violent short circuit through one of the armature-windings of the idle balancer in case the balancer is connected to the neutral or compensating conductor before it is up to speed. This usually results from the carelessness of the operator in closing the switch in the neutral or compensating conductor before closing the switch which connects the balancer to the main conductors of the system or before the balancer is up to speed or in neglecting to open the switch in the neutral or compensating conductor when the balancer was shut down at the close of a preceding run or operation.

On account of the good regulating qualities of compound-wound dynamo-electric machines it is desirable to employ them in balancers. It has been proposed to employ in the balancer two compound-wound dynamo-electric machines having series field-windings which are between the armature-windings and are shunted by a low-resistance

conductor, the low-resistance conductors of two balancers connected in parallel being connected together by a single equalizer.

This arrangement has many advantages, one

5 of which is that a single equalizer only is necessary for two balancers. However, since the equalizer is between the armatures there is a considerable difference of potential between the equalizer and each main conductor of the system, and therefore danger of
10 a short circuit between the equalizer and one of the machines of the balancer which is being connected to the system if the equalizer is connected to that balancer before the latter
15 is up to speed, in the same manner as when the neutral or compensating conductor is connected to the balancer before it is up to speed. Therefore in compound-wound balancers there is a danger of a short circuit
20 through either the neutral or compensating conductor or through the equalizing-conductor if, either the neutral or compensating switch or the equalizer-switch is closed before the balancer is up to speed.

25 The object of my invention is to provide means for avoiding the danger of short circuit through one of the armature-windings of a balancer and the consequent injury to that winding and to the translating devices when
30 the balancer is started from rest and connected to a multiple-voltage system, especially when it is connected to a system in parallel with one or more other balancers.

In carrying out my invention I so arrange
35 the main switch and one or more switches in a conductor or conductors through which there is danger of a short circuit, as a neutral switch, or equalizer-switch, preferably by interlocking the same, that when the main
40 switch is opened the neutral or equalizer switch, or both, will likewise be opened, and that the latter switch or switches cannot be closed unless the main switch is also closed.

My invention further consists in certain
45 novel combinations and arrangements of elements described in the specification and set forth in the appended claims.

For a better understanding of my invention reference is had to the accompanying
50 drawings, in which Fig. 1 shows a multiple-voltage system of distribution to which shunt-wound balancers equipped with my invention are adapted to be connected, and
55 Fig. 2 shows the multiple voltage system to which compound-wound balancers equipped with my invention are adapted to be connected.

Referring first to Fig. 1, I have shown at 10 a source of current connected to the multiple-voltage system, consisting in this case of
60 main conductors 11 and 12 and a neutral or compensating conductor 13. It may be stated at this point that my invention is applicable to the multiple-voltage systems of
65 distribution in which the voltages between

the neutral or compensating conductors and the main conductors are equal, called the "symmetrical voltage systems," and to the systems in which the voltages between the neutral or compensating conductors and the
70 main conductors are unequal, called the "unsymmetrical voltage systems." My invention can also be applied as well to systems having more than three conductors as to systems having three conductors.

75 At 14 and 15 are shown, respectively, two shunt-wound balancers adapted to be connected to the multiple-voltage system to supply voltage in the well-known manner when the loads are unbalanced or are unequal. Each balancer consists of two dynamo-electric machines 16 and 17, machine 16 consisting of an armature 18 and a shunt field-winding 19 and machine 17, consisting
80 of an armature 20 and a shunt field-winding 21. The armatures 18 and 20 are connected, respectively, to conductors 22 and 23, which in turn are adapted to be connected by a double-pole main switch 24 to the main conductors 11 and 12 of the system. At 25 is
90 shown the starting-rheostat, which in this case is located between the armature 18 and conductor 22. Each balancer is adapted to be connected to the neutral or compensating conductor 13 by a single-pole neutral or compensating switch 26. For reasons to be explained more fully the double-pole
95 main switch 24 and the single-pole neutral or compensating switch are mechanically interlocked, so that when the main switch is opened it will engage and open the switch 26. In this case the double-pole switch 24 is provided with a lateral extension 27 and the single-pole switch 26 is provided with a
100 lateral extension 28, the extension 28 overlapping the extension 27 of switch 24. Thus it is seen that although switch 26 can be opened independently of switch 24 when both are closed, switch 24 cannot be opened
105 without switch 26 also being opened and switch 26 cannot be closed unless switch 24 is also closed. At 29 is shown a three-pole load switch or circuit-breaker adapted to connect the translating devices to or disconnect them from the balancers and the
110 source of current.

The purpose and advantage of interlocking the main switch 24 and neutral or compensating switch 28 will now be explained more fully. Suppose, for example, that both
120 switches could be manipulated independently of each other and that the operator desires to connect a balancer to the system in parallel with a balancer which is already running and connected thereto. Ordinarily he
125 would first close double-pole switch 24 and then bring the balancer up to speed by moving the rheostat-arm to its running position, and when the balancer is up to speed and is developing sufficient counter electromotive
130

force he would close switch 26. In case, however, the operator should close switch 26 before he closed switch 24 or in case at the end of a preceding run he neglected to open switch 26 after opening switch 24 and should attempt to start the balancer by closing switch 24 there would be a violent short circuit through the neutral or compensating conductor and armature 20. The result would be that the neutral or compensating conductor would be brought to substantially the same potential as the main conductor 12, and the lamps between conductors 11 and 13 would be subjected to the entire voltage of the system. Machine 20 and the lamps between conductors 11 and 13 would therefore probably be injured or burned out. The same disastrous result would occur if there were only a single balancer in the system and the operator should close the load-switch 29 and the single-pole switch 26 before the balancer is brought up to speed. When the switches are arranged according to my invention, it is seen that a danger of a short circuit is very much reduced, for the reason that at the end of a run the operator can never open the main switch 24 without also opening the neutral or compensating switch 26. Therefore if the operator does not close switch 26 until after the balancer is up to speed there is no danger of the short circuit.

I have shown shunt-wound balancers each consisting of two shunt-wound dynamo-electric machines. My invention so far described could, however, be applied equally well to balancers each of which consists of a dynamotor having the motor and generator armature-windings arranged on a single armature-core.

Reference is now had to Fig. 2 of the drawings. In this figure, two balancers 30 and 31, each consisting of compound-wound dynamo-electric machines 32 and 33, are adapted to be connected in parallel to the system. Machine 32 consists of an armature 34, series field-winding 35, and shunt field-winding 36; and machine 33 consists of armature 37, series field-winding 38 and shunt field-winding 39. Armatures 34 and 37 are connected to conductors 40 and 41, which in turn are adapted to be connected to the main conductors 11 and 12 of the system by means of a double-pole switch 42. The series windings are located between the armatures and are shunted by low-resistance conductor 43. As in the preceding case, a starting-rheostat 44 is located between the armature 34 and the conductor 40. An equalizer is shown at 45, which equalizer is adapted to be connected to the two low-resistance conductors 43 of the balancers 30 and 31. Since the equalizer is connected to the two balancers at points between the armatures thereof, as was previously stated, there is a considerable differ-

ence of voltage between the equalizer and either main conductor, and therefore there is danger of a short circuit through the equalizer and an armature of a balancer if the equalizer should be connected to that balancer before it is up to speed and developing counter electromotive force. In this case, as with the shunt-wound balancers, the neutral or compensating conductor 13 is adapted to be connected to each balancer between the armatures, and therefore there is the same danger of short circuit through the neutral or compensating conductor as was explained in the case of the shunt-wound balancers. I connect the equalizer 45 and the compensating conductor to each balancer by means of a double-pole switch 46, which has one pole in the equalizer-conductor and another pole in the neutral or compensating conductor. To lessen the danger of a short circuit, I interlock the double-pole switches 42 and 46, so that when the main switch 42 is opened switch 46 will be engaged and will also be opened, and so that switch 46 cannot be closed without first or at the same time closing switch 42. Each main switch 42 is provided with a lateral projection 47 and each switch 46 is provided with a lateral projection 48, which overlaps the lateral projection on the main switch 42, so that although switch 46 can be opened independently of switch 42 when both switches are closed switch 42 cannot be opened without switch 46 also being opened. A three-pole load-switch is shown at 49, which switch connects the translating devices to the main source of current and to the balancers.

It is seen that with my invention danger of a short circuit either through the neutral or compensating conductor or through the equalizer is avoided, since the equalizer or neutral switch is opened at the same time the main switch is opened. Moreover, if the switches are so constructed mechanically that the interlocking feature is apparent at a glance this feature will serve as a visual signal of warning and will remind the operator of the danger involved in a manipulation of the switches in the wrong order and the operator is less likely to manipulate the switches and the starting-box in any but the correct order than when my invention is not employed.

I do not desire to be confined to the exact details of construction or to the exact connections shown, as many changes can be made without departing from the spirit and scope of my invention. For example, instead of employing a single equalizer between two balancers two equalizers can be employed in which there are single or double pole switches interlocked with the main switches, or instead of employing double-pole switches 42, 44, and 46 single-pole switches can be employed.

What I claim as new, and desire to secure by Letters Patent, is—

1. In a multiple-voltage system of distribution, a plurality of conductors comprising main and neutral or compensating conductors, a balancer comprising armature-windings, and means comprising conductors and interlocked switches for connecting the windings to said main and compensating conductor.

2. In a multiple-voltage system of distribution, a plurality of conductors comprising two main conductors and a neutral or compensating conductor, a balancer having two armature-windings, a switch for connecting the windings to the main conductors, and a switch for connecting the windings to the neutral or compensating conductor, said switches being so arranged that the opening of the second-named switch is controlled by the first, and that the second-named switch cannot be closed unless the first-named switch is also closed.

3. In a multiple-voltage system of distribution, a plurality of conductors comprising main conductors and a neutral or compensating conductor, one or more balancers adapted to be connected to said system, each balancer having a main switch for connecting the balancer to the main conductors, and a neutral or compensating switch for connecting the balancer to a neutral or compensating conductor, said switches being so arranged that when the main switch is opened it will engage and open the neutral switch, and that the neutral switch cannot be closed unless the main switch is at the same time or previously closed.

4. In a multiple-voltage system of distribution, a plurality of main and compensating conductors, a plurality of balancers adapted to be connected to said system in parallel, an equalizer, each balancer having a main switch and an equalizer-switch, said switches being so interlocked that by opening the main switch the equalizer-switch is also opened.

5. In a multiple-voltage system of distribution, a plurality of conductors comprising two main and a compensating conductor, a plurality of balancers adapted to be connected thereto in parallel, an equalizer, and a plurality of switches for connecting each balancer to the main conductors, to the neutral or compensating conductor, and to an equalizer, said switches being mechanically interlocked so that they will all be opened when the main switch is opened and cannot be closed unless the main switch is also closed.

6. In a multiple-voltage system of distribution, a plurality of conductors comprising main and neutral or compensating conductors, a plurality of balancers adapted to be connected thereto in parallel, an equalizer, and a plurality of switches for connecting

each balancer to the main conductors, to the neutral or compensating conductor and to the equalizer, each switch having a portion extending over or in the path of movement of another switch or a portion thereof so that all the switches will be opened when the switch connecting the balancer to the main conductors is opened and cannot be closed unless the main switch is also closed.

7. In a multiple-voltage system of distribution, a plurality of conductors comprising two main conductors and a neutral or compensating conductor, a plurality of balancers adapted to be connected thereto in parallel, an equalizer, each balancer consisting of compound-wound dynamo-electric machines, a main multipole switch for connecting the balancer to the main conductors, and a multipole switch for connecting the balancer to the neutral or compensating conductor and to the equalizer, said switches being interlocked so that when the first-named switch is opened the second-named switch is also opened and cannot be closed unless the main switch is also closed.

8. In a multiple-voltage system of distribution, a plurality of conductors comprising main conductors and a neutral or compensating conductor, a plurality of balancers adapted to be connected thereto in parallel, an equalizer for said balancers, each balancer consisting of compound-wound dynamo-electric machines, and having a main multipole switch for connecting the balancer to the main conductors, and a multipole switch for connecting the balancer to the neutral or compensating conductor and to the equalizer, the last-named switch having a portion overlapping or in the path of movement of the main switch, so that when the main switch is opened it will engage and open the other switch, and the latter cannot be closed unless the main switch is also closed.

9. In a multiple-voltage system of distribution, a plurality of conductors comprising main and neutral or compensating conductors, one or more balancers having one or more main switches and one or more neutral or compensating switches, the latter being interlocked with the former so that they are opened when the former are opened and cannot be closed unless the former are also closed.

10. In a multiple-voltage system of distribution, a plurality of main and compensating conductors, a balancer adapted to be connected thereto, and a plurality of main and compensating switches interlocked so that the opening of the former controls the opening of the latter and the latter cannot be closed without the former being closed.

11. In combination, a main source of current, a plurality of balancers, a plurality of main, compensating, and equalizer conductors, and a plurality of main and equalizer switches for each balancer, the said switches

being so arranged that the opening of the latter is controlled by the former, and the latter cannot be closed without the former being closed.

5 12. In combination, a main source of current, a plurality of balancers, a plurality of main, compensating, and equalizer conductors, and a plurality of switches for connecting each balancer to said conductors, the said
10 switches being so interlocked that by the opening of a main switch the switch or

switches connecting the balancer to the compensating and equalizer conductors are opened and the latter cannot be closed unless the said main switch is closed.

In testimony whereof I affix my signature
in the presence of two witnesses. 15

BUDD FRANKENFIELD.

Witnesses:

ARTHUR F. KWIS.

FRED J. KINSEY.