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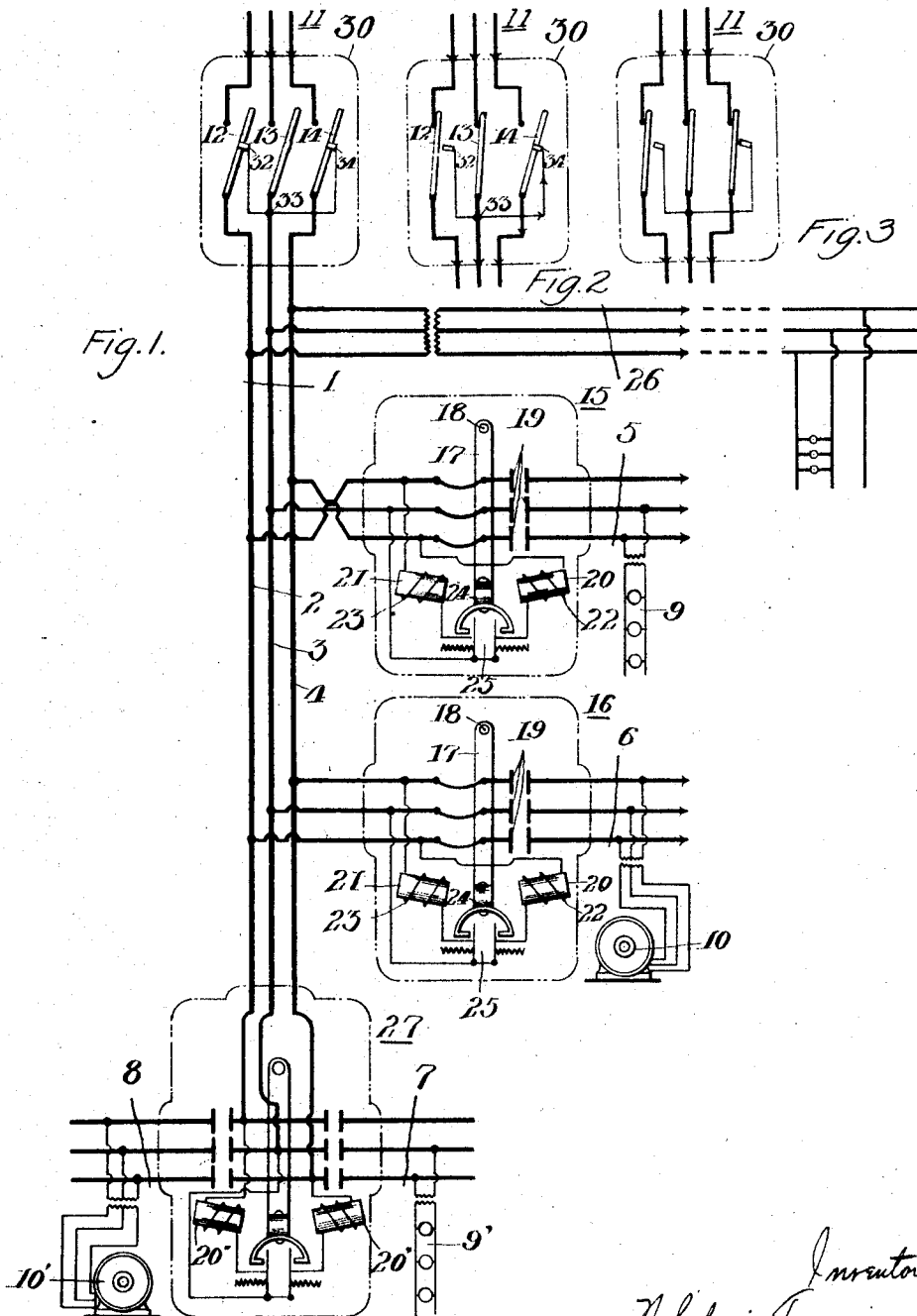
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DISTRIBUTION SYSTEM FOR SELECTIVE CONNECTIONS THERETO OF FEEDERS

Filed May 16, 1924

2 Sheets-Sheet 1



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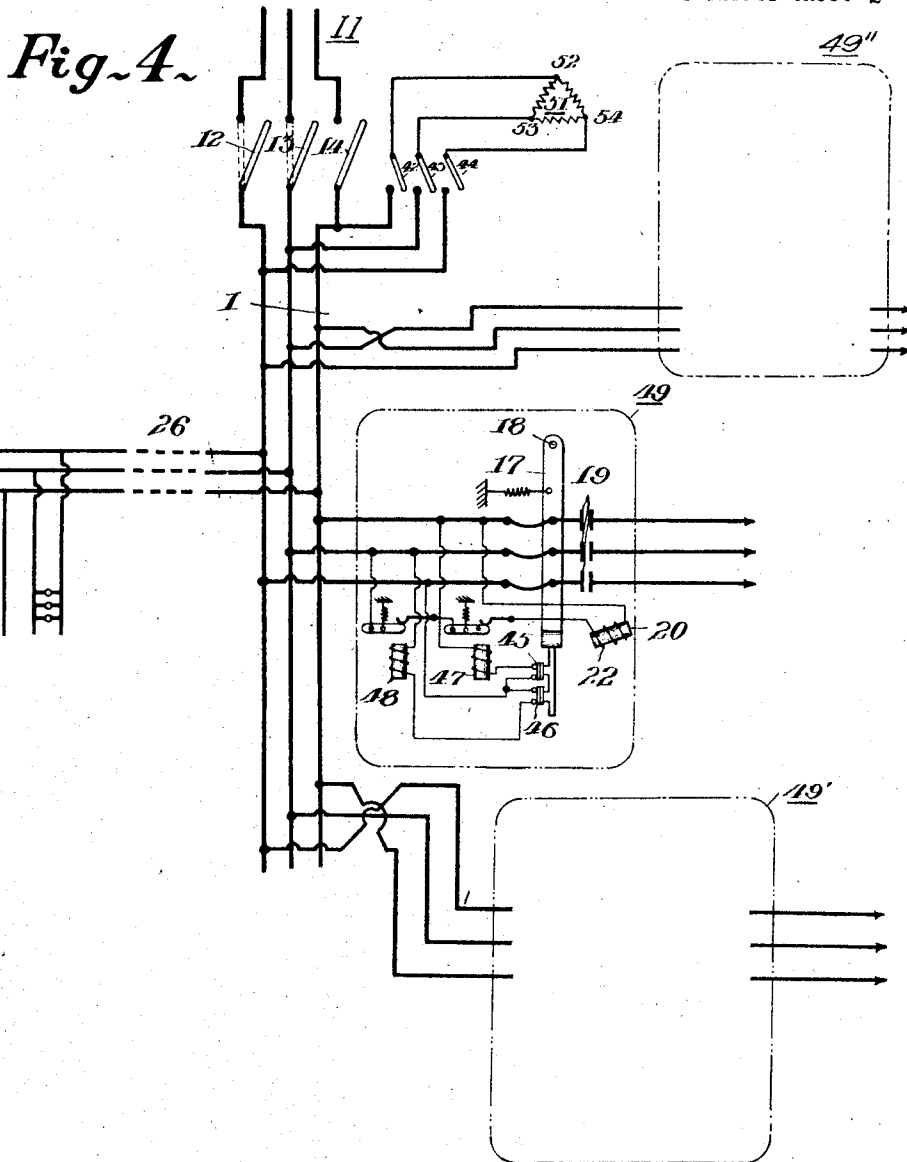
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UNITED STATES PATENT OFFICE.

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DISTRIBUTION SYSTEM FOR SELECTIVE CONNECTIONS THERETO OF FEEDERS.

Application filed May 16, 1924. Serial No. 713,833.

My invention relates to a control system of an electric power distribution and more particularly to the control system of the distribution wherein several feeders or groups of feeders are controlled selectively to be connected to a main circuit.

One object of my invention is to provide a control system which shall be operated through a pair of the conductors of the main circuit, and shall require no extra pilot or control conductor.

Another object of my invention is to provide a control system which shall be devoid of any uncertainty in the operation of the system due to disturbing effects resulting from the floating potential in the conductor or conductors in the main circuit other than the controlling pair.

A still further object of my invention is to provide a control system which is simple in construction and reliable in operation.

In a distribution system wherein there are two or more feeders or groups of feeders to which energy may be supplied from a common main circuit and wherein it is desirable to energize one feeder or one group of the feeders, selectively controlling energization from a point where the main circuit is controlled, it has been proposed to provide means for accomplishing the desired selective energizing of the feeders, in which switches of special feature are selectively operated through the conductor in the main circuit by energizing the conductors in a predetermined sequence. Such means is shown for example, in my co-pending application, Serial No. 490,976, filed August 9, 1921.

However, with such system, when there is connected to the main circuit a feeder, or feeders not controlled selectively in the manner as hereinbefore described and supplying energy to unbalanced load, the operation of said selective means becomes uncertain or oftentimes inoperative. It, therefore, becomes necessary to provide a remedy for such a failure of the system and I propose to accomplish this by providing a means by which all conductors other than the controlling pair in the main circuit are held at such a potential relation to each other and to said controlling pair as to under-energize electric devices connected thereto, during the selective operation performed.

My invention will best be understood

from the accompanying drawings wherein there are diagrammatically illustrated, the system of the distribution, and apparatus required for the selective operation of the character hereinbefore mentioned.

Figure 1 is a diagrammatic view of a system arranged according to my invention for connecting to a main circuit selectively one or other feeder or group of feeders, while in Figs. 2 and 3 are shown the positions of control switches during the selective operation. Fig. 4 is a similar view of a modification wherein the operation is made possible to select one out of three feeders or groups of feeders.

Since the control means that is adapted for selectively connecting to a main circuit, one out of two feeders or groups of feeders by energizing the conductors of the main circuit in a predetermined sequence, is described in detail in the above-mentioned application, only a brief resume thereof will be given in the present application, reference being made to the above-mentioned application for the full and complete disclosure thereof.

Referring to Fig. 1, a main circuit 1 comprising conductors 2, 3 and 4, is adapted to be connected to a source of energy 11, by a switching means 30 and to transmit the energy to a plurality of current-consuming devices 9, 10, 9' and 10', respectively through feeders, 5, 6, 7 and 8, the supply of the energy to the feeders 5 and 6, is controlled by switches 15 and 16, respectively, while the selective energization of the feeders, 7 and 8 is controlled by switch 27. There is connected to the main circuit 1, another feeder 26, whereto the supply of the energy is not controlled by switch, such as the switch 15, 16 or 27, as in the case of the feeders 5, 6, 7 or 8.

The switch 15, is provided with an arm 17 adapted to swing about a pivot-pin 18. A set of contact-making devices 19 which serve to connect feeder circuit 5 to the main circuit 1, is so mounted on the arm 17 as to close the contacts 19, when the arm 17 swings in one direction from its normal position. While the arm 17 is in its normal position or swings therefrom in the opposite direction, the contacts 19 are kept open. Electromagnets 20 and 21 are adapted, acting on their common armature 24 mounted on the arm 17, to move the arm 17 in the direction of closing the contacts 19 when

the magnet 20 is energized, and in the opposite direction when the magnet 21 is energized.

The electromagnets 20 and 21 are provided with windings 22 and 23, respectively, and their circuits are provided with circuit-breaking devices 25, which are operated by means of the arm 17 and so arranged, while one of the windings, 22 and 23, is being energized, to maintain the other winding open-circuited. The circuit-breaking devices 25 are maintained in their closed position while neither of the windings 22 and 23 is energized.

The switch 16 which is adapted to connect the feeder 6 to the main circuit, is in construction identical to the switch 15, but the connections of the electromagnet windings 22 and 23 therein are different in the following respects. The circuits of the winding 22 in the switch 15 and also of the winding 23 in the switch 16, extend between the conductors 3 and 4, and those of the winding 23 in the switch 15 and also of the winding 22 in the switch 16, extend between the conductors 2 and 3.

It, therefore, follows that when the conductors 2 and 3 only are energized, the switch 16 closes its contacts 19 and the winding 23 in the switch 16 becomes open-circuited, while the switch 15 is kept in its open position, the circuit of its closing magnet winding 22 are being open-circuited. Finally, when the conductor 4 is energized, the current-consuming device 10 is supplied with energy from the source 11, through the circuits 1 and 6, while the current-consuming device 9 is cut off from the source of energy 11, by the switch 15.

On the other hand, when the conductors 3 and 4, are energized first, and finally the conductor 2, the device 9 is connected to the source of energy 11 and the device 10 remains cut off therefrom. Such selective energization of the conductors 2, 3 and 4, as described hereinabove, is accomplished by simply closing in proper sequence the switches 12, 13 and 14, connecting the source of energy 11 and the conductors 2, 3 and 4 respectively.

The switches 15 and 16 may be combined into one, for example, as shown by switch 27, wherein the swinging arm is so constructed and arranged as, when it swings in one direction, to connect with the main circuit, one of the current-consuming devices 9' and 10' which are desired to operate selectively, and when it swings in the other direction, to connect with the main circuit, the other device. The construction and the operation of the switch 27 will be obvious without further description.

The present invention contemplates the prevention of uncertainty or non-effectiveness in the operation on the part of the se-

lective switches, under certain conditions which results usually from unbalanced loading of the main circuit. When there is feeder or feeders, for example, feeder 26, connected to the main circuit but not controlled by selective switch like the switch 15, 16 or 27, and if the loading of such feeder or feeders is substantially balanced, the operation of the selective switches 15, 16 and 27, which control the connection of the other feeders to the common main circuit, is satisfactory. However, when there is a certain amount of unbalance on the loading of the feeder 26, for instance, heavy load being connected between the conductors 2 and 4 and light load between the conductors 3 and 4, the condition is equivalent to the conductors 2 and 4 being connected with a low resistance or impedance, and the conductors 3 and 4 with comparatively high resistance or impedance. Under such condition, when the conductors 2 and 3 are energized in order to operate, as illustrated hereinbefore, the selective switch 16 to close its contacts 19 and the selective switch 15 to keep its contacts 19 open, the desired selective operation of the switches 15 and 16 may not take place satisfactorily on account of that, because the conductors 2 and 4 are in the state of being connected with low resistance or impedance, the electromagnets 20 and 21 connected between the conductors 2 and 3, and 2 and 4, respectively, are energized substantially equally and fail to force the arm 17 to swing.

In order to provide against such failure of the system as illustrated hereinabove, I have devised a means, whereby the electromagnets which are not to operate in order to produce a desired selective operation, are held either underenergized, or non-energized, during the selective operation. One of the forms of the means is best illustrated by an auxiliary device which co-operates with the main switching means 20. The device comprises stationary contact members 32 and 34, which are in engagement with the switches 12 and 14, respectively, while the switches are in their open position, but each becomes disengaged when the corresponding switch is closed.

It may be supposed to happen that, when one of the switches 12 or 14 is thrown into the position shown in Fig. 2, any synchronous or induction machines on the system 26 would be short circuited by their one phase, and if the short circuit current is quite large and continued for quite a long period, any circuit breaker on the system would open. But this is merely a failure of such kind that could not occur in a practical or commercial distribution system.

In practical use, the feeder system 26 provides quite a long feeder line between the

control switch 30 and the load. The load may comprise resistances and synchronous and induction machines. Sometimes it comprises resistance load only, in which case the failure as hereinbefore pointed out does not occur at all. When the load comprises synchronous or induction machines only, a comparatively high resistance or impedance of the line usually exists mainly due to a considerable long distance to the load, and there could not occur the short circuiting of the one phase of machines to enable the circuit breakers to open. Moreover, circuit breakers have a more or less time limit to effect operation, while the operation of the control switches is completed almost instantaneously, and the switch 14 in Fig. 2 is promptly closed before the circuit breakers open. The whole system thus operates positively. The members 32 and 34 are both connected to the conductor 3 at a point 33.

When desired, as in the case illustrated hereinabove, to energize the conductors 2 and 3 in order to operate the selective switch 16 to close and the selective switch 15 to remain opened, the switches 12 and 13 are closed and the switch 14 left open as illustrated in Fig. 2. Then the switch 12 disengages with the contact member 32 but the switch 14 remains in contact with the member 34, keeping the conductors 3 and 4 at the same potential. This energizes all the electromagnets connected between the conductors 2 and 3 only, for instance, magnets 21 of the switch 15, magnet 20 of the switch 16, but prevents the energization of all magnets connected between the conductors 3 and 4, and is obtained a satisfactory selective operation of switches 15 and 16, even under the condition of unbalanced loading of the circuit. Finally, the switch 14 is closed, its engagement with the contact member 34 being broken, as illustrated in Fig. 3, and then there is obtained, as desired, the selective energization from the circuit 1 to the feeders branching therefrom, that is, to energize the circuit 16 and to keep the circuit 15 disconnected. When desired to disconnect the circuit 16, it is required simply to open the switches 12, 13 and 14.

On the other hand, when desired to energize the circuit 15 and to have the circuit 16 disconnected, the switches 13 and 14 are closed and the switch 12 is kept open while the selective operation is performed. The operation of the selective energization of the system will be obvious, being similar to that in the case described hereinabove, without any further description.

With the device as illustrated hereinbefore, it is limited to the selection of either one out of two, that is, out of two groups of feeders, to energize the first group while the second group is disconnected from the

main circuit, or to energize the second group while the first group is disconnected. The device, however, may be so modified as to make possible the selective energization of any one out of three. The modification is illustrated in Fig. 4. Three feeders or groups of feeders, of which any one may be connected to the main circuit 1, while the other two are kept disconnected therefrom, are each provided with selective switches, as illustrated with switches 49, 49' and 49''. The switches are identical in their construction but different in their connections to the main circuit.

There are connected to the main circuit 1, other feeders, as illustrated by feeder 26, which is loaded in an unbalanced manner as in the case hereinbefore illustrated.

Each of switches 49, 49' and 49'' is provided with a swinging arm 17 which is adapted, when it swings, to close the contacts 19 to connect the feeder controlled by the switch, to the main circuit. The arm 17 is held normally by a spring to have its contacts 19 open. In the open position, the arm 17 is adapted to maintain contact devices 45 and 46 closed, and when the arm 17 is biased by the electromagnet 20, to close the main contacts 19, the contact devices 45 and 46 are opened. Electromagnets 47 and 48, each is adapted, when energized to act on its armature, to open the circuit of the magnet winding 22, and when deenergized to close the circuit.

The circuit of the windings 22 of the main contact-closing magnets 20 in the switches 49, 49' and 49'', are energized through a different pair of the conductors 2, 3 and 4, for instance, that of the switch 49 through the conductors 2 and 3, that of the switch 49' through the conductors 3 and 4 and that of the switch 49'' through the conductors 2 and 4, the latter two switches being not shown in the drawing, for the sake of brevity, but identical in construction with the switch 49 and adapted to be energized from respective proper pairs of the conductors, 3 and 4, and 2 and 4, and having no need of illustration. The electromagnets 47 and 48 in each of the switches 49, 49' and 49'', are energized through the pairs of the conductors 2, 3 and 4, other than the pair adapted to energize the electromagnet 20 in the switch.

The circuit 1 as illustrated in Fig. 4, is adapted to be connected to the source of energy 11 by switches, 12, 13 and 14. Switches 42, 43 and 44, which are connected respectively to three points 52, 53 and 54, equally spaced, of a loop resistance or impedance 51, are adapted to connect the corresponding points of the resistance or impedance, when closed, respectively to the conductors 2, 3 and 4 of the circuit 1. This element 51 corresponds to the conductor con-

necting the members 32, 33 and 34 in Fig. 1, but effects an additional function as herein-after disclosed.

In the operation of the devices, when desired to close one of the selective switches 49, 49' and 49'', for instance the switch 49 and to maintain other switches 49' and 49'', open, the switches 42, 43 and 44 are all closed and the switches 12 and 13, as indicated with the dotted lines, are closed to energize through the conductors 2 and 3, all magnets connected therebetween, for instance, the closing magnet 20 of the switch 49 and either of the open-circuiting magnets 47 and 48 in each of the switches 49' and 49''.

The resistance or impedance 51, is of such capacity as to render the effect on the main circuit 1, resulting from the unbalanced loading of the non-selective feeders, for instance, the feeder 26, negligible, or of such capacity at least as to maintain, when the switches 12 and 13 are closed, the voltages between the conductors 2 and 4, and 3 and 4, insufficient for the energization of the electromagnets connected therebetween, for instance, magnets 47 and 48 of the switch 49 and magnets 20 of switches 49' and 49'', to perform their respective functions, even when there is unbalanced loading of such feeders like the feeder 26.

It follows, therefore, that the selective switch 49 closes and the switches 49' and 49'' remain opened. Finally, when the switch 14 is closed and the switches 42, 43 and 44, are opened, there is obtained the desired selective energization of the feeders connected to the main circuit 1, without any pilot or controlling conductor other than those of the main circuit. The operation of the selective closing of the switch 49' or 49'', will be obvious from the illustration given hereinabove, without any further description.

With a distribution system comprising four conductors as in two-phase 4 wire system, it is possible to make the selective energization of one out of six feeders branching from a main circuit, by proper application of my invention. The selective switches may be of construction similar to the switches 49, 49' and 49'', except with provision of an extra number of the contacts like contact 19 of electromagnets such as magnet 47 or 48, each for opening the circuit of winding 20 and of the contact devices like the device 45 or 46, each for opening the circuit of each of the electromagnets like magnet 47 or 48. In this case the resistance or impedance device which corresponds to the resistance or impedance 51, in Fig. 4 may be modified as shown in Fig. 5. The resistance 71 consists of two parts with a common terminal 71'' and terminals 71' and 71''' at the other ends of the parts. The terminals 71', 71'' and 71''' are connected respectively to

common terminals of the groups of switches 72', 73', 74' and 75', 72'', 73'', 74'' and 75'', and 72''', 73''', 74''' and 75'''. The other terminals of the switches 72', 72'' and 72''' are all connected to conductor 72, those of the switches 73', 73'', and 73''', all to the conductor 73, those of the switches 74', 74'', and 74''', all to the conductor 74, and those of the switches 75', 75'' and 75''', all to the conductor 75. The conductors 72, 73, 74 and 75, that make up a main circuit 61, are provided with switches 62, 63, 64 and 65, respectively for the purpose of connecting the conductors to the source of energy 11.

In the operation of the last mentioned distribution system, when desired to close one of the selective switches and to have all others remain opened, in order to energize only one feeder controlled by the switch, assuming that the switch desired to be closed is energized through a pair of the conductors 72 and 73, firstly, these conductors 72 and 73, are connected to the end terminals 71' and 71''' of the resistance 71, by closing the switches 72' and 73'''. secondly, the other conductors, 74 and 75, are connected to the middle terminal 71'' of the resistance by closing the switches 74'' and 75'', thirdly, the main switches 62 and 63 are closed to energize the closing magnet, like magnet 20, in the selective switch which is desired to be closed and to operate electromagnets, like magnet 47 or 48, to open the circuits of the closing magnets in all other selective switches which are desired to remain opened and finally, the connections to the resistance 71 are broken by opening the switches 72'', 73''', 74'' and 75''. and the remaining main switches 64 and 65 are closed. As the capacity of the resistance 71 is so chosen as to hold the conductors 64 and 65, substantially at neutral potential to the conductors 62 and 63, so that the effect of the unbalanced loading of the main circuit, as illustrated in the case described relative to Fig. 1, is made practically negligible. It will be obvious without any further description, that there is obtained the desired selective energization of the feeders branching from the main circuit.

The devices described hereinabove in connection with Fig. 5, may be modified to make applicable to the case described in connection with Fig. 4, and may be further modified to make applicable to cases wherein the main circuit comprises more than four conductors.

Modification in the system and arrangement and location of parts may be made within spirit and scope of my invention, and such modifications are intended to be covered by the appended claims.

I claim as my invention:—

1. The combination with a main circuit

comprising three conductors, a plurality of feeders, means for each of said feeders for connecting same to said main circuit, means for controlling said connecting means through a pair of said conductors and a plurality of other feeders connected to said circuit, of means for holding the conductors of said main circuit other than said pair at a predetermined potential relation to said pair whereby the proper operation of said controlling means is assured even when said other feeders are unbalanced.

2. The combination with a main circuit comprising three conductors, a plurality of feeders, means for each of said feeders for connecting same to said main circuit, means for controlling said connecting means through a pair of said conductors and a plurality of other feeders connected to said circuit, of means for holding the conductors of said main circuit other than said pair at the neutral potential between said pair of the conductors for assuring a proper operation of said controlling means even when the load on said other feeders is unbalanced.

3. The combination with a main circuit comprising three conductors, a plurality of feeders, means for each of said feeders for connecting same to said main circuit, means for controlling said connecting means through a pair of said conductors and other feeders connected to said main circuit, of means for holding the conductor of said main circuit other than said pair at the same potential with either of said pair during said controlling means operated, so that the proper operation of said means is assured even when said other feeders are loaded in an unbalanced manner.

4. Control system comprising a source of electrical energy, a main circuit comprising three conductors, a switch for each of said conductors for connection thereof to said source of energy, a plurality of feeders, a plurality of switches, one for each of said feeders for connection thereof to said main circuit, comprising a plurality of electromagnets, one for closing the feeder switch and the others for opening the circuit of said closing electro magnet, each energized through a different pair of said conductors, said closing electromagnet of each of said switches being energized through a different pair of said conductors, whereby selective closing of said switches is obtained by energizing through a proper pair of said conductors, and means for so under-energizing electromagnets other than those energized through said proper pair of the conductors as to render them inoperative.

5. Control system comprising a source of electrical energy, a main circuit comprising three conductors, a switch for each of said conductors for connection thereof to said source of energy, a plurality of feeders, a

plurality of switches, one for each of said feeders for connection thereof to said main circuit, comprising a plurality of electromagnets, one for closing the feeder switch and the others for opening the circuit of said closing electromagnet, each energize through a different pair of said conductors said closing electromagnet of each of said switches being energized through a different pair of said conductors, whereby selective closing of said switches is obtained by energizing through a proper pair of said conductors, and a resistance device adapted to be so connected to said conductors as to under-energize said electromagnets other than those energized through said proper pair of the conductors.

6. Control system comprising a source of electrical energy, a main circuit comprising three conductors, a switch for each of said conductors for connection thereof to said source of energy, a plurality of feeders, a plurality of switches, one for each of said feeders for connection thereof to said main circuit, comprising a plurality of electromagnets, one for closing the feeder switch and the others for opening the circuit of said closing electromagnet, each energized through a different pair of said conductors, said closing electromagnet of each of said switches being energized through a different pair of said conductors, whereby selective closing of said switches is obtained by energizing through a proper pair of said conductors, and an impedance device adapted to be so connected to said conductors as to under-energize said electromagnets other than those energized through said proper pair of the conductors.

7. Control system comprising a source of electrical energy, a main circuit comprising three conductors, a switch for each of said conductors for connection thereof to said source of energy, two groups of feeders, a plurality of switches, one for each of said feeders for connection thereof to said main circuit, comprising a plurality of electromagnets, one for closing the feeder switch and the other for opening the circuit of said closing electromagnet, each energized through a different pair of said conductors, said closing electromagnets for the switch for a group of said feeders being energized through a pair of said conductors and those for the switches for the other groups of feeders through another pair of said conductors, whereby selective connection of said two groups of feeders is obtained by energizing through a proper pair of said conductors, and means to connect the conductor common to the pairs of conductors for energizing of feeder switch closing magnets, to either of other conductors.

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