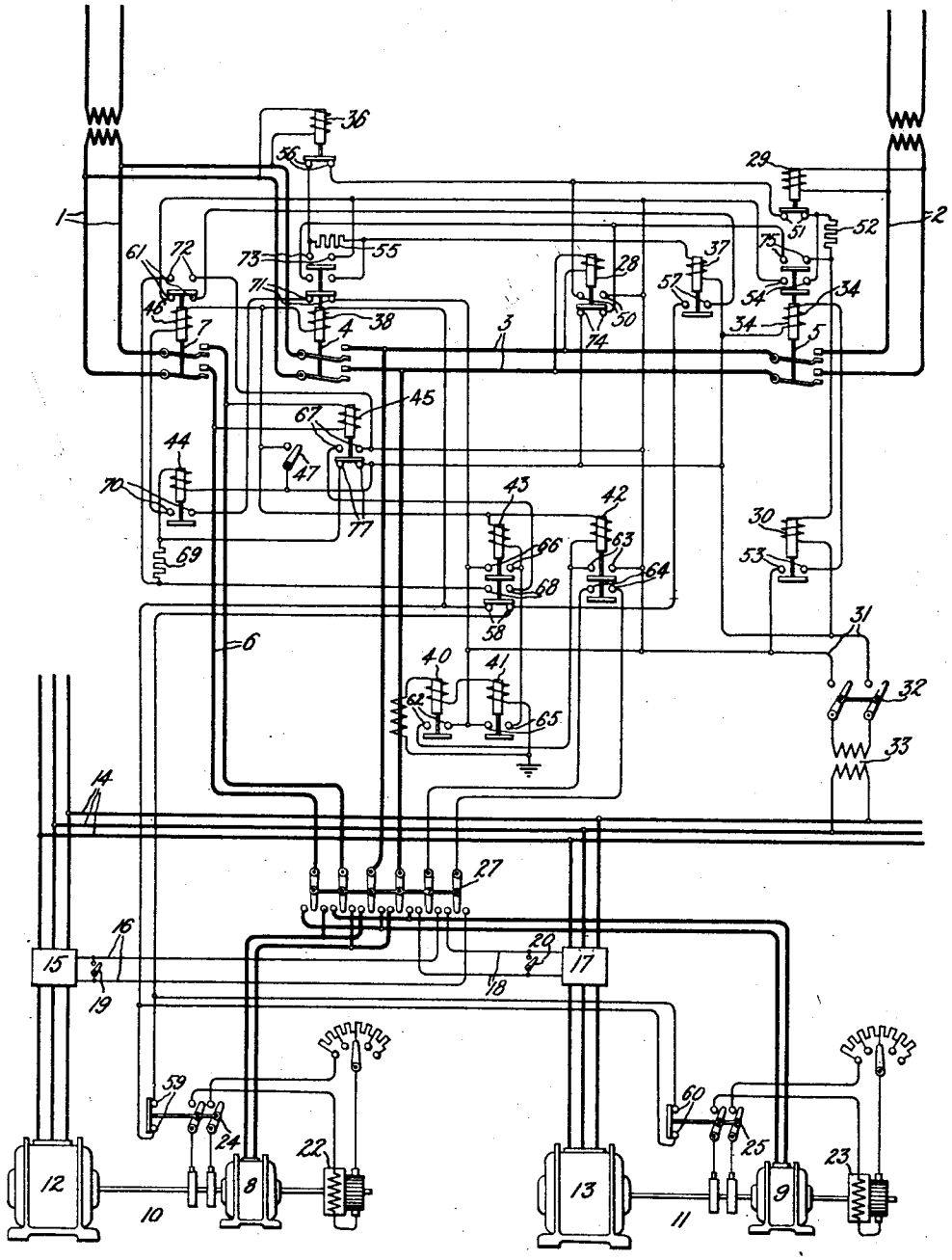
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AUTOMATIC SWITCHING EQUIPMENT

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## AUTOMATIC SWITCHING EQUIPMENT.

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My invention relates to automatic switching equipments and particularly to automatic switching equipments for controlling the connection between a plurality of sources of current and a plurality of load circuits so that under light load conditions all of the load circuits are supplied by the same source and under heavy load conditions certain of the circuits are independently supplied by different sources and one object of my invention is to provide an improved control arrangement for accomplishing this result.

In accordance with my invention I provide an arrangement whereby a plurality of load circuits are normally supplied by a preferred source of current and an auxiliary source which is arranged to supply certain of the load circuits when the preferred source if overloaded is normally inoperative. When the load on the preferred source reaches a predetermined value which indicates that the load is approaching a value at which it is desirable to place the auxiliary source in service, the auxiliary source is started and placed in an operative condition to supply current. When the load on the preferred source exceeds another predetermined value certain of the load circuits are disconnected from the preferred source and are connected to the auxiliary source. Suitable switching means is provided whereby either source may be made the preferred source and the other the auxiliary source.

My invention will be better understood from the following description taken in connection with the accompanying drawing which diagrammatically shows a control system for controlling the connection between two load circuits and two sources of current and the scope of my invention will be pointed out in the appended claims.

In the accompanying drawing 1 and 2 are two load circuits which are arranged to be connected to a main bus 3 by switches 4 and 5. The load circuit 1 is also arranged to be connected to an auxiliary bus 6 by a switch 7. The switches 4, 5 and 7 may be of any suitable type examples of which are well known in the art.

For supplying current to the main bus 3 and the auxiliary bus 6 I provide two sources of current which may be of any suitable type. As shown these sources are the generators 8 and 9 of motor generator sets 10 and 11 respectively, the respective motors 12 and 13 of which are arranged to be connected to a suitable source of current such as a supply circuit 14. The motors 12 and 13 are provided with suitable automatic switching means respectively whereby the starting of each motor generator set is effected by the completion of a starting circuit associated therewith. Since such automatic switching systems are old and well known in the art and the details thereof constitute no part of my present invention, I have deemed it unnecessary to complicate the drawing by showing these switching means in detail.

The automatic switching means 15 (not shown in detail) for the motor 12 is arranged to be operated to effect the starting of the motor 12 whenever a starting circuit 16 associated therewith is completed. The automatic switching means 17 (not shown in detail) associated with the motor 13 is similarly arranged to be operated to effect the starting of the motor 13 whenever a starting circuit 18 associated therewith is completed. Manually controlled switches 19 and 20 are shown as one particular arrangement for effecting at will the completion of the starting circuits 16 and 18 respectively. Any other suitable control means, however, examples of which are well known in the art may be provided for accomplishing this result.

For exciting the generators 8 and 9 I provide the exciters 22 and 23 which are directly connected to the motors 12 and 13 respectively and which are arranged to be connected to the field windings of the generators 8 and 9 respectively by suitable field switches 24 and 25. These switches 24 and 25 may be controlled either automatically or manually in any suitable manner examples of which are well known in the art.

In order that either generator may be made the preferred source and the other the auxiliary source I provide a transfer switch 27 which is arranged when in one position to connect the generator 8 to the main bus 3 and the generator 9 to the auxiliary bus 6 and which is arranged when in another position to connect the generator 9 to the main bus 3 and the generator 8 to the auxiliary bus 6.

Under light load conditions both of the switches 4 and 5 are closed so that the load

circuits 1 and 2 are connected to the main bus 3 and therefore are supplied by whichever source is connected thereto. The closing of the switch 5 between the bus 3 and the load circuit 1 is controlled by means of a voltage relay 28 which is connected so as to be responsive to the voltage of the bus 3 and a voltage relay 29 which is connected to the load circuit 2 so as to be responsive to the voltage thereof. When the main bus 3 is energized and the load circuit 2 is deenergized and energizing circuit is completed through the contacts of the relays 28 and 29 for a control relay 30 across a suitable source of control current 31. In the arrangement shown in the drawing the control circuits 31 is arranged to be connected by means of a manually controlled switch 32 to the secondary of a potential transformer 33, the primary of which is connected to the supply circuit 14. The control relay 30 when energized completes a circuit for the closing coil 34 of the switch 5 across the control circuit 31 so that the switch 5 is closed. The switch 5 when closed completes a locking circuit for the control relay 30 so that the opening of the contacts of the voltage relay 29 due to the energization of the load circuit 2 does not effect the deenergization of the control relay 30.

The closing of the switch 4 between the main bus 3 and the load circuit 1 is controlled by the voltage relay 28 which is responsive to the voltage of the bus 3 and also by a voltage relay 36 which is connected across the load circuit 1 so that it is responsive to the voltage thereof. When the main bus 3 is energized and the load circuit 1 is deenergized a circuit is completed for the control relay 37 through the contacts of the relays 28 and 36. When the relay 37 is energized it completes a circuit for the closing coil 38 of the switch 4 if the switch 7 is open and either of the field switches 24 or 25 is open indicating that both generators are not excited or the current output of the source connected to the main bus 3 is below a predetermined value, thereby indicating that the source is not overloaded.

In accordance with one feature of my invention the auxiliary motor generator set is normally shut down so that it is in an inoperative condition to supply current to the auxiliary bus and is arranged to be started automatically and to be placed in an operative condition to supply current to the auxiliary bus when the current output of the source connected to the main bus reaches a predetermined value. When the current output of the source connected to the main bus reaches a greater predetermined value a portion of the load is disconnected from the main bus and is connected to the auxiliary bus. In the arrangement shown in the drawing this result is accomplished in the following manner. Two relays 40 and 41 are connected to the main bus 3 in any suitable manner so that they are energized in accordance with the current output of the source connected to the main bus. When the current output of the source connected to the main bus reaches a predetermined value the relay 40 operates and completes the circuit of a control relay 42 associated therewith. This control relay in turn completes the starting circuit of the automatic switching means associated with whichever motor generator set is the auxiliary source. In order that this relay may complete the proper starting circuit the transfer switch 27 is provided with suitable contacts so that in each operative position of the switch the contacts of the relay 42 are connected across the starting circuit of whichever source is the auxiliary source.

If the output of the source connected to the main bus exceeds a greater predetermined value the relay 41 completes the circuit of an auxiliary relay 43 associated therewith. The energization of the relay 43 effects the opening of the switch 4 so as to disconnect the load circuit 1 from the main bus 3. The energization of the relay 43 also completes a circuit for an auxiliary control relay 44 if the voltage across the auxiliary bus 6 is above a predetermined value, so that the voltage relay 45, which is connected across the auxiliary bus 6, is energized a predetermined amount. As soon as the control relay 44 becomes energized and the switch 4 is opened a circuit is completed for the closing coil 46 of the switch 7 to close the switch 7 and connect the load circuit 1 to the auxiliary bus 6. The circuit of the closing coil 46 includes the manually controlled switch 47 which is provided so that the switch 7 may be opened to effect the disconnection of the load circuit 1 from the auxiliary bus 6 and its reconnection to the main bus 3 when the total load on the two load circuits is such that it may be supplied by one source without overloading it.

The operation of the arrangement shown in the accompanying drawing is as follows: Let it be assumed that the switches 24, 25, 32 and 47 are closed and that the transfer switch 27 is in its left hand position so that the generator 9 is connected to the auxiliary bus 6 and the generator 8 is connected to the main bus 3. When it is desired to supply current to the load circuits 1 and 2 from the main source 8 the manually controlled switch 19 is closed so as to effect the completion of the starting circuit 16 and the operation of the automatic switching means 15 associated with the motor 12 to start the motor generator set 10. As soon as the voltage of the generator 8 builds up to a predetermined value the voltage relay 28 operates to close its contacts 50. If at this time the load circuit 2 is not energized by some other source the contacts 51 of the voltage relay 29 will be closed

and a circuit will be completed for the coil of the control relay 30. This circuit is from one side of the control circuit 31 through the coil of the relay 30, resistor 52, contacts 51, of relay 29, contacts 50 of relay 28 to the other side of the control circuit 31. The relay 30 by closing its contacts 53 connects the closing coil 34 of the switch 5 across the control circuit 31 so that the load circuit 2 is connected to the main bus 3. By closing its auxiliary contacts 54 the circuit breaker 5 completes a locking circuit for the relay 30 so that this relay is not deenergized by the opening of the contacts 51 of the relay 29 when the load circuit 2 is energized.

If the load circuit 1 is not energized by some other source at the time the relay 28 closes its contacts 50 a circuit is completed for the control relay 37. This circuit is from one side of the control circuit 31 through the coil of relay 37, resistor 55, contacts 56 of relay 36, contacts 50 of relay 28 to the other side of the control circuit. Relay 37 by closing its contacts 57 completes a circuit for the closing coil 38 of the switch 4. This circuit is from one side of the control circuit 31 through switch 47, closing coil 38 of switch 4, the parallel connected contacts 58, 59 and 60 of relay 43 and field switches 24 and 25 respectively, contacts 57 of relay 37, auxiliary contacts 61 on switch 7 to the other side of the control circuit. The energization of the closing coil 38 closes the switch 4 so that the load circuit 1 is connected to the main bus 3. Switch 4 by closing its auxiliary contacts 73 completes a shunt around the contacts 56 of relay 36 and contacts 50 of relay 28 so that the subsequent energization of the relay 36 does not effect the deenergization of the control relay 37.

When the current output of the source 8 exceeds a predetermined amount the current relay 40 closes its contacts 62 and completes the circuit of the control relay 42. This circuit is from one side of the control circuit 31 through switch 47, the coil of relay 42, contacts 62 of relay 40 to the other side of the control circuit 31. The relay 42 by closing its contacts 63 completes a circuit in parallel around the contacts 62 of relay 40 so that the relay 42 remains energized in case the relay 40 subsequently opens its contacts 42. Relay 42 by closing its contacts 64 which are connected in the starting circuit by the means of the transfer switch 27 effects the operation of the automatic switching means 17 associated with the motor 13 of the motor generator set 11. The automatic switching means 17 then effects the starting of the motor generator set 11 so that the generator 9 is placed in an operative condition to supply current to the load circuit 1 when the switch 7 is subsequently closed.

When the current output of the source 8 exceeds a greater predetermined value the current relay 41 closes its contacts 65 and thereby completes a circuit for the control relay 43. This circuit is from one side of the control circuit 31 through the switch 47, the coil of relay 43, contacts 65 of relay 41 to the other side of the control circuit 31. Relay 43 by closing its contacts 66 completes a circuit in parallel around the contacts 65 of relay 41 so that the relay 43 remains energized in case the relay 41 should subsequently open its contacts 65. The relay 43 by opening its contacts 58 effects the deenergization of the closing coil 38 of the switch 4 if both of the field switches 24 and 25 are closed at this time. The deenergization of the closing coil 38 of the switch 4 causes the switch 4 to open and disconnect the load circuit 1 from the main bus 3. If the voltage across the auxiliary bus 6 is above a predetermined value so that the contacts 67 of the voltage relay 45 are closed at the time the relay 43 operates, a circuit for the control relay 44 is completed through the contacts 68 of the relay 43. This circuit is from one side of the control circuit 31 through the coil of the relay 44, resistor 69, contacts 68 of relay 43, contacts 67 of voltage relay 45 to the other side of the control circuit 31. As soon as the switch 4 opens and the relay 44 is energized a circuit is completed through the contacts 70 of the relay 44 for the closing coil 46 of the switch 7. This circuit is from one side of the control circuit 31 through the switch 47, closing coil 46 of switch 7, contacts 70 of relay 44, auxiliary contacts 71 of switch 41 to the other side of the control circuit 31. The energization of the closing coil 46 effects the closing of the switch 7 so that the load circuit 1 is connected to the auxiliary bus 6. Each of the load circuits is now independently energized by a separate source of current.

Switch 7 by closing its auxiliary contacts 72 completes a locking circuit for the control relay 44 which is independent of contacts 68 of relay 43 and contacts 67 of relay 45.

If at any time the source connected to the main bus 3 becomes deenergized so that the voltage relay 28 opens its contacts 50 and closes its contacts 74, shunt circuits are completed around the coils of the control relays 30 and 37 so that the opening of the switches 4 and 5 is effected. The shunt circuit around the coil 30 includes the contacts 74 of the relay 28 and the auxiliary contacts 75 of the switch 5. The shunt circuit around the coil of the relay 37 includes the contacts 74 of the relay 28 and the auxiliary contacts 75 on the switch 4. Therefore, whenever the source connected to the main bus fails both of the load circuits are disconnected from the main bus. In a similar manner if the source connected to the auxiliary bus 6 fails while the switch 7 is closed the opening of the switch 7 is effected so as to disconnect the load circuit from the auxiliary bus. This result is

obtained in the following manner. When the source connected to the auxiliary bus 6 fails the voltage relay 45 closes its contacts 77 and thereby completes a shunt circuit around the coil of the control relay 44. The deenergization of the coil of relay 44 opens the circuit of the closing coil 46 of the switch 7.

If it is desired to make the generator 9 a preferred source the transfer switch 27 is placed in its right hand position in which position the generator 9 is connected to the main bus 3 and the generator 8 is connected to the auxiliary bus 6 and the contacts 64 of the relay 42 are connected in the starting circuit 16 of the automatic switching means 15 associated with the motor 12 so that when the relay 42 is energized the starting of the motor 12 is effected. The operation of the arrangement when the transfer switch 27 is in its right hand position will be obvious from the above description.

While I have in accordance with the patent statutes shown and described my invention as applied to a particular system and as embodying various devices diagrammatically indicated changes and modifications will be obvious to those skilled in the art and I, therefore aim in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. In combination, a plurality of load circuits, a source of current normally connected to all of said circuits, a second source of current normally in an inoperative condition to supply current, means responsive to a predetermined output of said first mentioned source for controlling the operation of said second source so that it is put in an operative condition to supply current, and means responsive to another predetermined output of said first mentioned source for effecting the disconnection of certain of said load circuits from the first mentioned source and the connection thereof to said second source.

2. In combination, two electric circuits, a source of current normally connected to both circuits, a dynamo-electric machine normally at rest, means responsive to a predetermined current output of said source for starting said machine and placing it in a condition to supply current, and means responsive to a greater predetermined current output of said source for controlling the disconnection of one of said circuits from said source and the connection of said one of said circuits to said machine.

3. In combination, two electric circuits, a source of current normally connected to both circuits, a motor generator set normally at rest, means responsive to a predetermined current output of said source for effecting the starting of said motor generator set, means responsive to a greater predetermined current output of said source and an electrical condition of said set for effecting the disconnection of one of said circuits from said source, and means responsive to the disconnection of said one of said circuits from said source for effecting the connection thereof to the generator of said set.

4. In combination, two electric circuits, two buses, two sources of current, switching means for connecting each source to either bus, means responsive to the energization of one of said buses for connecting both electric circuits thereto and means responsive to a predetermined current output of the source connected to said one of said buses for effecting the disconnection of one of said circuits therefrom and the connection of said one of said circuits to the other bus.

5. In combination, two electric circuits, two buses, a source of current connected to one of said buses, another source connected to the other bus and normally in an inoperative condition to supply current thereto, means responsive to the voltage of said one of said buses for connecting both of said circuits thereto, means responsive to a predetermined current output of the source connected to said one of said buses for controlling said other source so that it energizes said other section, and means responsive to a greater predetermined current output of the source connected to said one of said buses for effecting the disconnection of one of said circuits from said one of said buses and the connection of said one of said circuits to the other bus.

6. In combination, two buses, two motor generator sets, a transfer switch for connecting the generator of said sets to either bus, and a plurality of load circuits normally connected to one of said buses, means responsive to a predetermined current output of whichever source is connected to said one of said buses for effecting the automatic starting of the other motor generator set, and means dependent upon a greater predetermined current output of whichever source is connected to said one of said buses and a predetermined condition of said other motor generator set for effecting the disconnection of certain of said load circuits from said one of said buses and the subsequent connection thereof to the other bus.

7. In combination, two buses, two motor generator sets, a transfer switch for connecting the generator of said sets to either bus, and a plurality of load circuits normally connected to one of said buses, means responsive to a predetermined current output of whichever source is connected to said one of said buses for effecting the automatic starting of the other motor generator set, means dependent upon a greater predetermined cur-

rent output of whichever source is connected to said one of said buses and the excitation of the generators of both motor generator sets for effecting the disconnection of certain of said load circuits from said one of said buses, and means dependent upon predetermined energization of said other bus and the disconnection of said certain of said load circuits from said one of said buses for effecting the connection of said certain of said load circuits to said other bus.

In witness whereof, I have hereunto set my hand this 23rd day of April, 1928.

RALSTON E. BEAR.