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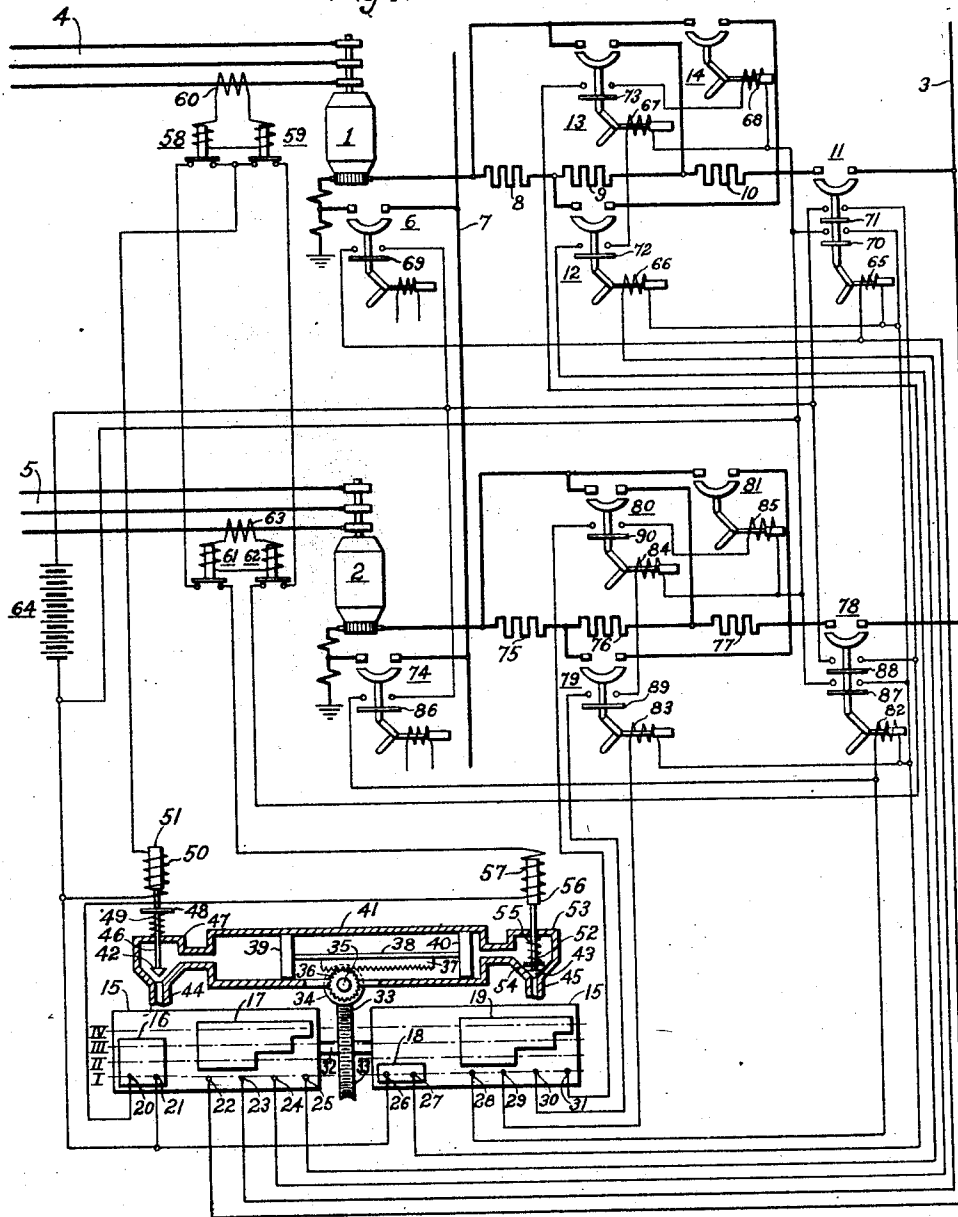
S. G. LEONARD

AUTOMATIC STATION

Filed Dec. 29, 1925

2 Sheets-Sheet 1

Fig. 1.



WITNESSES:

E. J. Keller
Att. Punditor

INVENTOR

Stuart G. Leonard

BY

Herley & Co.
ATTORNEY

Dec. 27, 1927.

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S. G. LEONARD

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2 Sheets-Sheet 2

Fig. 2.

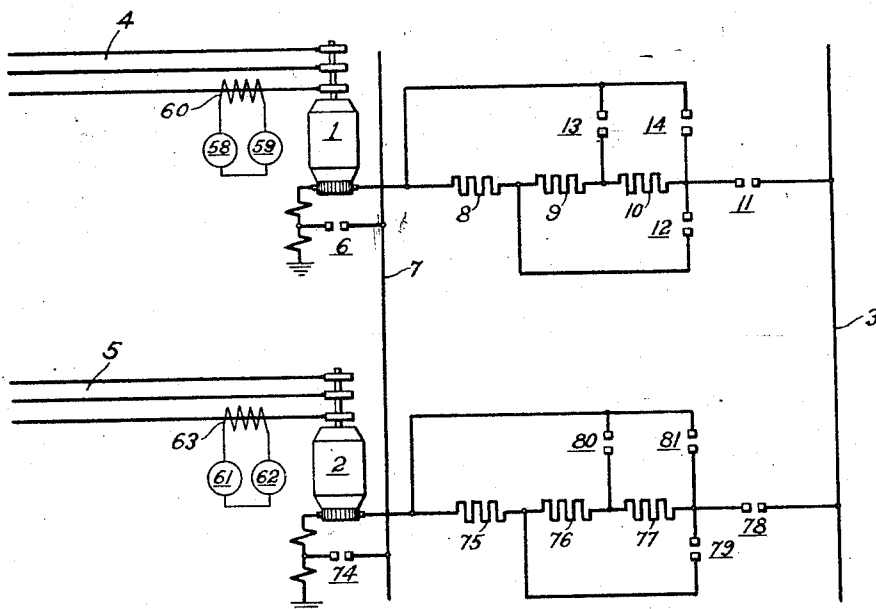
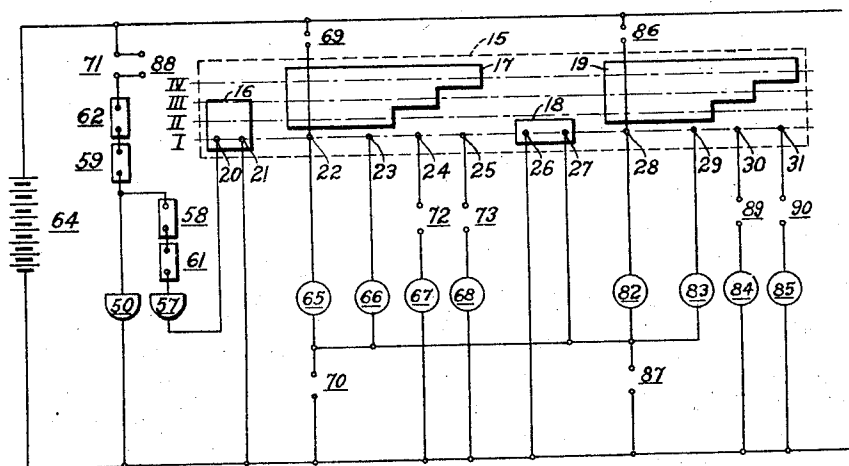


Fig. 3.



WITNESSES:

G. J. Miller

Abt. Pendleton

INVENTOR

Stuart G. Leonard

BY

Wesley C. Leonard
ATTORNEY

UNITED STATES PATENT OFFICE.

STUART G. LEONARD, OF LAKEWOOD, OHIO, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

AUTOMATIC STATION.

Application filed December 29, 1925. Serial No. 78,165.

My invention relates to automatic stations and more particularly to stations comprising a plurality of electrical translating devices for supplying energy to a common consuming circuit.

An object of my invention is to provide means for limiting the amount of energy that may be supplied to the consuming circuit by any one translating device and means for simultaneously controlling the effectiveness of the load-limiting means of all of the translating devices that are operating in a station, in such manner that the total load will be distributed between the several operating devices equally or in a predetermined ratio.

My invention comprises in general, an electrical translating station including two or more electrical translating devices adapted to supply energy to a common consuming circuit. A plurality of load-limiting resistors are connected between each of the translating devices and the consuming circuit and means are provided for short-circuiting the resistors under normal operating conditions. A common means is provided for controlling the operation of all of the resistor short-circuiting means of the several translating devices simultaneously. This means comprises, in its preferred form, an electro-pneumatically operated contact drum that may be caused to turn in either direction to open or close corresponding resistor short-circuiting means of all of the operating translating devices simultaneously.

A plurality of load-responsive devices are associated with the several translating devices and are adapted to control the operation of the contact drum in such manner that when any one of the translating devices is traversed by current in excess of a predetermined value the contact drum open-circuits corresponding resistor short-circuiting means of all of the operating translating devices to decrease the amount of energy that is supplied to the consuming circuit. When all of the translating devices are traversed by current of less than a predetermined value, the load-responsive devices cause the drum to turn in the opposite direction to close the resistor short-circuiting means of the several translating devices simultaneously, thereby permitting the translating devices to supply a greater amount of energy to the consuming circuit.

By providing means of the above indicated character for effecting simultaneous operation of the load-limiting means of the several translating devices in a station, unequal distribution of load between the several devices which is undesirable and which may be injurious to the devices, is precluded.

In the accompanying drawings,

Figure 1 is a diagrammatic representation of an electrical system embodying my invention, including power apparatus and circuits and auxiliary apparatus and circuits for controlling the power apparatus,

Fig. 2 is a schematic representation of the power apparatus and circuits shown in Fig. 1, and

Fig. 3 is a schematic representation of the auxiliary or control apparatus and circuits shown in Fig. 1.

Like reference characters in the different figures indicate like pieces of apparatus.

Referring to the drawings, two electrical translating devices 1 and 2 are adapted to supply energy to a common consuming circuit 3. The translating devices 1 and 2 are illustrated as rotary converters receiving energy from supply circuits 4 and 5, respectively. It will be understood that the circuits 4 and 5 may be connected to the same supply system through proper transformers, starting and running circuit interrupters, and such other devices as may be necessary or desirable.

My invention is particularly adapted to be utilized in a station in which the translating devices are automatically controlled, but since the automatic controlling devices do not constitute an integral part of my invention, and since such devices are now well known in the automatic station art, they are not shown or described in this application.

One of the direct-current terminals of the converter 1 is connected through a series field-magnet winding and an inter-pole field-magnet winding to earth. An equalizer contactor 6 is connected from the point between the series field-magnet winding and the inter-pole field-magnet winding to an equalizer bus conductor 7. The other direct current terminal of the converter 1 is connected through a plurality of resistors 8, 9 and 10 and a circuit interrupter 11 to the consuming circuit 3.

Circuit interrupters 12, 13 and 14 are provided for varying the effectiveness of the resistors 8, 9 and 10. The circuit inter-

rupters 12, 13 and 14 are so connected with respect to the resistors 8, 9 and 10 that when all of these circuit interrupters are open, all of the resistors are connected in series; when the circuit interrupter 12 is closed and the circuit interrupters 13 and 14 are open, the resistors 9 and 10 are short-circuited and only the resistor 8 is effective; when the circuit interrupters 12 and 13 are closed and the circuit interrupter 14 is open, the resistors 8, 9 and 10 are connected in parallel relation to each other; and when the circuit interrupter 14 is closed, all of the resistors 8, 9 and 10 are short-circuited and, therefore, ineffective.

A drum member 15 is provided with contact segments 16, 17, 18 and 19 and contact fingers 20 to 31, inclusive, which co-operate to control the operation of the circuit interrupters 11, 12, 13 and 14 that are associated with the converter 1, and corresponding circuit interrupters associated with the converter 2, which will be described presently. The drum member 15 is mounted on a shaft 32 to which a worm wheel or spiral gear wheel 33 is secured. The wheel 33 is engaged by a worm or spiral pinion gear 34 that is mounted on a shaft 35. A pinion gear 36 is also mounted on the shaft 35 and meshes with a rack member 37 that is secured to a piston rod 38. The rod 38 is provided with pistons 39 and 40 at opposite ends thereof. The pistons 39 and 40 are encased by opposite ends of a cylinder 41.

Valves 42 and 43 are adapted to control the admission of air or other operating fluid from supply pipes or conduits 44 and 45 to the respective ends of the cylinder 41. The valve 42 is provided with a stem 46 and a housing 47. A pin 48 is secured to the valve stem 46 and engages one end of a compression spring 49, the other end of which engages the valve housing 47 in such manner that the valve 42 is normally held out of engagement with its seat, thereby permitting pressure to be applied to the piston 39 from the supply pipe or conduit 44. A magnet coil 50 co-operates with a magnetic core member 51 that is secured to the upper end of the valve stem 46 in such manner that when the coil 50 is energized the core member 51 is actuated downwardly to close the valve 42 against the pressure of the spring 49.

The valve 43 is provided with a stem 52 and a housing 53. A pin 54 is secured to the stem 52 and engages one end of a compression spring 55, the other end of which engages the housing 53. Thus, it will be seen that the valve 43 is controlled by the spring 55 in a similar manner to that in which the valve 42 is controlled by the spring 49, but that the spring 55 normally maintains the valve 43 in engagement with

its seat whereas the spring 49 normally maintains the valve 42 out of engagement with its seat. The upper end of the valve stem 52 is provided with a magnetic core member 56 with which a magnet coil 57 is adapted to co-operate. When the magnet coil 57 is energized, the core member 56 is actuated upwardly, thereby opening the valve 43 against the pressure of the spring 55 to admit operating fluid from the supply pipe or conduit 45 to the right-hand end of the cylinder member 41.

From the foregoing description of the actuating means of the drum member 15, it will be seen that when both the magnet coils 50 and 51 are de-energized, the valve 42 is open and the valve 43 is closed. Therefore, fluid pressure is applied to the piston 39 but no pressure is applied to the piston 40. The pistons 39 and 40 and the rod 38 are, therefore actuated to the extreme right-hand position, as shown in the drawing, and the drum member 15 is turned to the position shown in the drawing by means of the rack 37, the pinion gear 36, the shaft 35, the worm or spiral pinion gear 34, the worm wheel or spiral gear wheel 33 and the shaft 32.

When both the magnet coils 50 and 57 are energized, the valve 42 is closed and the valve 43 is open, thereby relieving the pressure on the piston 39 and applying pressure to the piston 40. The pistons 39 and 40, the rod 38 and the rack 37 are thereupon actuated to their extreme left-hand position, thereby turning the drum member 15 in such manner that the contact fingers 20 to 31, inclusive, successively engage or disengage the contact segments 16, 17, 18 and 19 in the positions indicated by the broken lines II, III and IV in the drawings.

When the magnet coil 50 is energized and the magnet coil 57 is de-energized, both the valves 42 and 43 are closed and no pressure is applied to either of the pistons 39 and 40. Therefore, the pistons 39 and 40 remain stationary in whatever position they occupy, and the drum member 15 likewise remains stationary, until the magnet coil 57 is energized or the magnet coil 50 is de-energized.

The energization of the magnet coils 50 and 57 is controlled by overload relays 58 and 59 that are associated with the supply circuit 4 of the converter 1 through the agency of a current transformer 60, and overload relays 61 and 62 that are associated with a supply circuit 5 of the converter 2 through the agency of a current transformer 63. Each of the overload relays 58, 59, 61 and 62 is provided with a single switch that is closed except when the associated current transformer, and hence the relay operating coils, are traversed by current in excess of a predetermined value, caused by an excessive current

traversal of the supply circuits 4 and 5. The switches of the overload relays are adapted to connect the magnet coils 50 and 57 between the terminals of a battery or other source of energy 64 under predetermined conditions.

The battery 64 is also adapted to supply energy for the operation of the circuit interrupters 11, 12, 13 and 14 through operating magnet coils 65, 66, 67 and 68, respectively. The energization of the coils 65, 66, 67 and 68 is controlled by the contact drum 15 and by an auxiliary switch 69 of the equalizer contact 6, auxiliary switches 70 and 71 of the circuit interrupter 11, an auxiliary switch 72 of the circuit interrupter 12 and an auxiliary switch 73 of the circuit interrupter 13, each of these auxiliary switches being closed when the contactor or circuit interrupter with which it is associated is closed.

The converter 2 is provided with an equalizer contactor 74 corresponding to the equalizer contactor 6 of the converter 1 and connected in the same manner to the equalizer bus conductor 7. Resistors 75, 76 and 77 and circuit interrupters 78, 79, 80 and 81 are associated with the converter 2 in the same manner that resistors 8, 9 and 10 and circuit interrupters 11, 12, 13 and 14, respectively, are associated with the converter 1. Circuit interrupters 78, 79, 80 and 81 are provided with operating magnet coils 82, 83, 84 and 85, respectively. An auxiliary switch 86 of the equalizer contactor 74, auxiliary switches 87 and 88 of the circuit interrupter 78, an auxiliary switch 89 of the circuit interrupter 79 and an auxiliary switch 90 of the circuit interrupter 80 are connected in the same manner as the corresponding auxiliary switches of the equalizer contactor 6 and the circuit interrupters 11, 12, 13 and 14 that are associated with the converter 1.

Having thus described the apparatus and circuits of the system embodying my invention, I will now describe the method in which the system operates to accomplish the desired objects. Assuming that both the converters 1 and 2 are at rest and that conditions have arisen in response to which it is desired that one of the converters be started, converter 1 may be started and brought up to the proper speed and voltage with the correct polarity by any suitable means well known in the art. When this condition is obtained, the first step preliminary to connecting the converter 1 to the circuit 3 is the closing of the equalizer contactor 6, which is accomplished by energizing its operating coil in any suitable manner.

When the equalizer contactor 6 is closed its auxiliary switch 69 is also closed to complete a circuit from the upper terminal of the battery 64, through the switch 69, the operating coil 65 of the circuit interrupter 11, the contact finger 27, contactor segment 18 and

contact finger 26 of the contact drum 15, to the lower terminal of the battery 64. The coil 65 is thus energized to effect closing of the circuit interrupter 11, which connects the direct-current end of the converter 1 to the circuit 3 through the resistors 8, 9 and 10 in series. The converter 1 will then supply energy to the circuit 3 through the resistors 8, 9 and 10.

If the load assumed by the converter 1 when the circuit interrupter 11 is closed is excessive, the current transformer 60 will be sufficiently energized, by reason of the excessive current traversing the supply circuit 4, to energize the overload relay 58 to such a degree that it will open its switch. The overload relay 59 may also be energized sufficiently to open its switch, but since the switches of the relays 58 and 59 must both be closed before the next step in the sequence of operation can take place, the opening of the switch 59 has no further effect than the opening of the switch 58. The relay 59 is calibrated to operate at a higher current value than is the relay 58, for a purpose which will be hereafter set forth.

When the amount of energy supplied to the circuit 3 by the converter 1 has decreased to a predetermined value, both of the overload relays 58 and 59 will be permitted to close their switches. When these switches are closed, a circuit is established from the upper terminal of the battery 64, through the auxiliary switch 71 of the circuit interrupter 11, which was closed when the circuit interrupter 11 closed; the switch of the overload relay 62 that is associated with the supply circuit 5 and is de-energized because the converter 2 is not operating; the switch of the relay 59; and the magnet coil 50 that is associated with the operating mechanism of the contact drum 15, to the lower terminal of the battery 64. The magnet coil 50 is thus energized to close the valve 42, thereby relieving the pressure on the piston 39. At the same time, the magnet coil 57 is energized by means of a circuit extending from the upper terminal of the battery 64 through the auxiliary switch 71 of the circuit interrupter 11, the switches of the overload relays 62, 59, 58 and 61 in series, the coil 57, and the contact finger 20, contact segment 16 and contact finger 21 of the contact drum 15, to the lower terminal of the battery 64.

When the magnet coil 57 is thus energized, it effects opening of the valve 43, which then admits air to create pressure on the piston 40 in the right-hand end of the cylinder 41. The pistons 39 and 40 are, therefore, moved to the left to turn the contact drum 15 in such manner that the position indicated by the broken line II coincides with the line of the contact fingers.

In position II of the contact drum the contact segment 18 is out of engagement

with the fingers 26 and 27, but the circuit of the operating coil 65 of the circuit interrupter 11 is not open, since the auxiliary switch 70 of the circuit interrupter 11 is connected in parallel relation to the contact fingers 26 and 27 to constitute a holding circuit for the coil 65. When the contact drum is in position II, a circuit is completed from the upper terminal of the battery 64 through the auxiliary switch 69 of the equalizer contactor 6, the contact finger 22, contact segment 17, contact finger 23, operating coil 66 of the circuit interrupter 12, and auxiliary switch 70 of the circuit interrupter 11 to the lower terminal of the battery 64. The operating coil 66 is thus energized to close the circuit interrupter 12, which short-circuits the resistors 9 and 10 and leaves only the resistor 8 in circuit between the converter 1 and the circuit 3.

If the decreased resistance between the converter and the consuming circuit permits an excessive current to traverse the converter, the overload relay 58 will open its switch to interrupt the circuit of the magnet coil 57. The valve 43 is, therefore, closed to relieve the pressure on the piston 40, and the movement of the pistons and the contact drum is stopped. Assuming that the load is not excessive, however, the switches of the overload relays will remain closed, the energization of the magnet coils 50 and 57 will be maintained and the contact drum 15 will be so turned that it will be engaged by the contact fingers in the positions indicated by the broken line III. In this position a circuit is completed from the upper terminal of the battery 64, through the auxiliary switch 69 of the equalizer contactor 6, the contact finger 22, contact segment 17 and contact finger 24 of the contact drum 15, the auxiliary switch 72 of the circuit interrupter 12, which was closed when the circuit interrupter 12 closed, and the operating coil 67 of the circuit interrupter 13 to the lower terminal of the battery 64.

When the operating coil 67 is thus energized, the circuit interrupter 13 is closed to connect the resistors 8, 9 and 10 in parallel relation to each other between the converter 1 and the circuit 3. The resistance of this circuit is thus further decreased to permit the converter 1 to supply more energy to the circuit 3. If this amount of energy is not excessive, the overload switches will remain closed and the contact drum 15 will be turned so that position IV coincides with the contact fingers. In this position, a circuit is established from the upper terminal of the battery 64 through the auxiliary switch 69 of the equalizer contactor 6, the contact finger 22, the contact segment 17 and the contact finger 25 of the contact drum 15, the auxiliary switch 73

of the circuit interrupter 13, which was closed when the circuit interrupter 13 closed, and the operating coil 68 of the circuit interrupter 14 to the lower terminal of the battery 64.

Upon energization of the operating coil 68 over this circuit, the circuit interrupter 14 is closed to short-circuit all of the resistors 8, 9 and 10 or, in other words, to connect the converter 1 directly to the circuit 3. In position IV of the contact drum, the contact segment 16 is out of engagement with the contact fingers 20 and 21 and the circuit of the magnet coil 57 is thereby interrupted to permit the valve 43 to be closed. Thus, when the piston 40 has been actuated to its extreme left-hand position the pressure thereon is relieved.

The converter 1 is now normally connected between the supply circuit 4 and the consuming circuit 3 to translate energy therebetween. When it is desired that the converter 2 be started to operate in parallel relation to the converter 1, its operation may be started in the same manner as described with respect to the converter 1. The same operations will then take place up to and including the closing of the equalizer contactor 74 which corresponds to the equalizer contactor 6 of the converter 1. When the equalizer contactor 74 is closed, its auxiliary switch 86 is also closed to complete the energizing circuit of the operating coil 82 of the circuit interrupter 78. This circuit extends from the upper terminal of the battery 64, through the switch 86, the coil 82 and the auxiliary switch 70 of the circuit interrupter 11 to the lower terminal of the battery 64. The circuit interrupter 78 is thus closed to connect the converter 2 to the circuit 3 through the resistors 75, 76 and 77. If the load supplied by the converter 2 to the circuit 3 through the resistors 75, 76 and 77, when the circuit interrupter 78 is closed, is not excessive, the switches of the overload relays 61 and 62 will not be opened. The circuit of the magnet coil 50 will, therefore, not be interrupted and the valve 42 will remain closed to permit the pistons 39 and 40 to remain in the extreme left-hand position and to permit the contact drum 15 to remain in position IV. The circuit of the operating coil 83 of the circuit interrupters 79 will, therefore, be completed from the upper terminal of the battery 64, through the auxiliary switch 86 of the equalizer contactor 74, the contact finger 28, contact segment 19 and contact finger 29 of the contact drum 15, the coil 83 and the auxiliary switch 87 of the circuit interrupter 78 to the lower terminal of the battery 64.

As soon as the circuit interrupter 79 is closed in response to the energization of the coil 83, its auxiliary switch 89 is closed to complete the circuit of the operating coil 84

of the circuit interrupter 80, which extends from the upper terminal of the battery 64, through the auxiliary switch 86 of the equalizer contact 74; the contact finger 28, contact segment 19 and contact finger 30 of the contact drum 15; the auxiliary switch 89 of the circuit interrupter 79; and the operating coil 84 of the circuit interrupter 80, to the lower terminal of the battery 64. The operating coil 84 is thus energized to effect closing of the circuit interrupter 80 and the auxiliary switch 90 thereof, which completes the circuit of the operating coil 85 of the circuit interrupter 81.

This circuit extends from the upper terminal of the battery 64, through the auxiliary switch 86 of the equalizer contactor 74; the contact finger 28, contact segment 19 and contact finger 31 of the contact drums 15; the auxiliary switch 90 of the circuit interrupter 80; and the operating coil 85 of the circuit interrupter 81 to the lower terminal of the battery 64. The circuit interrupter 81 is thereupon closed to connect the converter 2 directly to the circuit 3 to supply energy thereto in parallel relation to the converter 1.

While the converters 1 and 2 are operating in parallel relation, an excessive current traversal of either of the supply circuits 4 and 5 will cause the corresponding overload relay 59 or 62 to open its switch, thereby interrupting the energizing circuit of the magnet coil 50 to permit the valve 42 to open. Since the valve 43 is closed, as previously set forth, there is no pressure on the piston 40 and the pressure applied to the piston 39 by reason of the opening of the valve 42 causes the pistons 39 and 40 to be moved to the right, thereby turning the contact drum 15 back to position III. In this position, the circuits of the operating coils 68 and 85 of the circuit interrupters 14 and 81 respectively, are interrupted to permit these circuit interrupters to open. Thus, one step of resistance is inserted between each of the converters and the consuming circuit 3 to decrease the amount of energy supplied by each converter. As long as the overload conditions persist in either converter, the backward movement of the drum 15 will be continued to increase the amount of resistance that is connected between each converter and the circuit 3.

Each time that the drum moves to a new position, the corresponding resistor short-circuiting circuit interrupters of the two converters are opened simultaneously, so that the relative value of resistance connected between each converter and the consuming circuit is always the same or, if the converters are of different capacities, in a predetermined ratio. The ratio of load distribution between the two converters is, therefore, unchanged by the operation of

the load-limiting means. In like manner, when the overload conditions no longer exist, the load-limiting resistors of the two converters are simultaneously short-circuited when the contact drum 15 is again turned in the forward direction by reason of the fact that the overload relays have again closed their respective switches.

As previously stated, the overload relays 58 and 61 are calibrated to operate at a lower value of current than are the relays 59 and 62. It is clear from the foregoing description that the opening of the switch of either of the relays 59 or 62 causes the contact drum 15 to be turned in the reverse direction, while the opening of the switch of either of the relays 58 or 61, while the switches of the relays 59 and 62 remain closed, only stops the operation of the contact drum and permits it to remain in whatever position it has assumed.

By means of the relative calibration of the overload relays, therefore, a certain degree of overload will simply stop the operation of the drum while a greater degree of overload will cause the drum to return in the reverse direction. For example, a current traversal of either of the circuits 4 and 5 of 1,000 amperes may cause the drum 15 to turn in the backward direction, but upon the insertion of one step of resistance between each of the converters and the consuming circuit, the consequent reduction of current will not necessarily cause the drum to move forward again unless the current is reduced below the operating value of the relays 58 and 61, which may be 750 amperes. Thus, as long as the value of current is between the settings of the relays 58 and 59 or 61 and 62 the drum will remain stationary.

It is obvious that the contact drum 15 may be provided with as many contact segments similar to the segments 17 and 19 as there are translating devices in the station to be controlled, and that all of the circuits may be extended in such manner that the load-limiting devices of as many translating devices as are desired may be controlled by a single contact drum. By this means, the load distribution between any number of translating devices may always be maintained in a constant ratio. It is also clear that various changes and modifications may be made in the apparatus and circuits of the system embodying my invention without departing from the spirit and scope thereof, as set forth in the appended claims.

I claim as my invention:

1. In an electrical translating station, the combination with a load circuit and a plurality of dynamo-electric machines for supplying energy thereto, of resistance means for connecting each machine to the circuit and means for automatically varying the effectiveness of the resistance means of all

the operating machines in a predetermined ratio simultaneously, in accordance with the value of current traversing the operating machines.

2. In an electrical translating station, the combination with a load circuit and a plurality of dynamo-electric machines for supplying energy thereto, of resistance means for connecting each machine to the circuit and means for automatically varying the effectiveness of the resistance means of all of the operating machines in a predetermined ratio simultaneously, in accordance with the value of current traversing any one of the operating machines.

3. In an electrical translating station, the combination with a load circuit and a plurality of dynamo-electric machines for supplying energy thereto, of resistance means for connecting each machine to the circuit and means for automatically varying the effectiveness of the resistance means of all of the operating machines equally and simultaneously, in accordance with the value of current traversing the operating machines.

4. In an electrical translating station, the combination with a load circuit and a plurality of dynamo-electric machines for supplying energy thereto, of resistance means for connecting each machine to the circuit and means for automatically varying the effectiveness of the resistance means of all of the operating machines equally and simultaneously in accordance with the value of current traversing any one of the operating machines.

5. In an electrical translating station, the combination with a load circuit and a plurality of dynamo-electric machines for supplying energy thereto, of a resistor associated with each machine, means for connecting each resistor between the associated machine and the load circuit when the machine is operating, means for short-circuiting all of the resistors under normal operating conditions, and means for open-circuiting the resistor short-circuiting means of all of the operating machines simultaneously when any one of the operating machines is traversed by current in excess of a predetermined value.

6. In an electrical translating station, the combination with a load circuit and a plu-

ality of dynamo-electric machines for supplying energy thereto, of a corresponding set of resistors associated with each machine, means for connecting each set of resistors between the associated machine and the load circuit when the machine is operating, means for short-circuiting all of the resistors under normal operating conditions, and means for open-circuiting the short-circuiting means of corresponding resistors of all of the operating machines simultaneously when any one of the operating machines is traversed by current in excess of a predetermined value.

7. In an electrical translating station, the combination with a load circuit and a plurality of dynamo-electric machines for supplying energy thereto, of a plurality of load-limiting resistors associated with each machine, means for connecting all of the resistors of each machine in series between the machine and the circuit when the machine is operating, means for short-circuiting each of the resistors and means for simultaneously controlling the resistor short-circuiting means of all of the machines comprising an electro-pneumatically operated contact drum and a plurality of load-responsive devices for controlling the operation of the drum.

8. In an electrical translating station, the combination with a load circuit and a plurality of dynamo-electric machines for supplying energy thereto, of a plurality of load-limiting resistors associated with each machine, means for connecting all of the resistors of each machine in series between the machine and the circuit when the machine is operating, means for short-circuiting each of the resistors, a contact drum for controlling the operation of all of the resistor short-circuiting means and means for so controlling the operation of the contact drum that corresponding resistor short-circuiting means of all of the operating machines are simultaneously open-circuited when any machine is traversed by current in excess of a predetermined value and simultaneously close-circuited when each of the machines is traversed by current of less than a predetermined value.

In testimony whereof, I have hereunto subscribed my name this 22 day of December, 1925.

STUART G. LEONARD.