Jan. 4, 1938. E. F. W. ALEXANDERSON 2,104,633

ELECTRIC VALVE CIRCUITS

Filed April 15, 1936 2 Sheets-Sheet 1

Fig. 1.

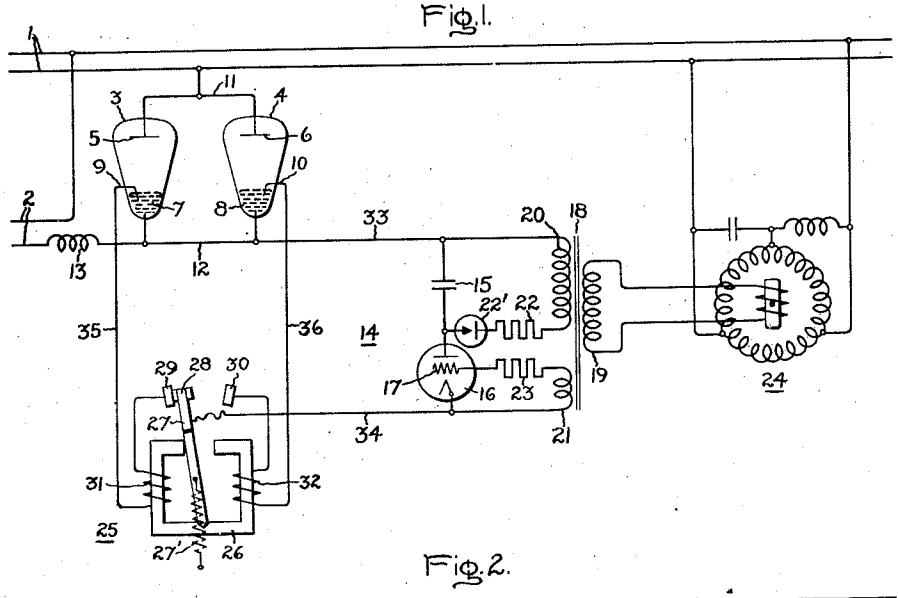
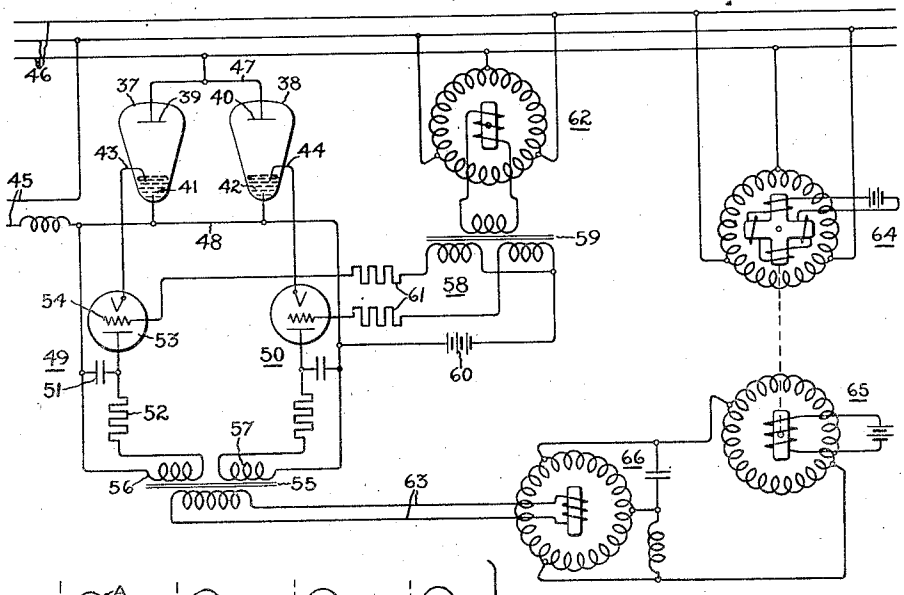


Fig. 2.



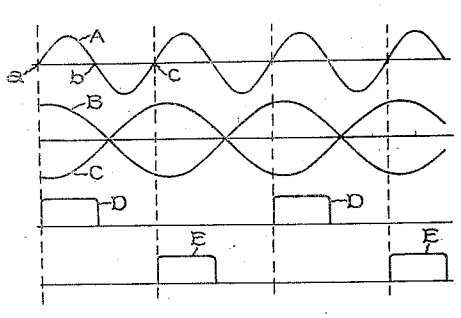


Fig. 3.

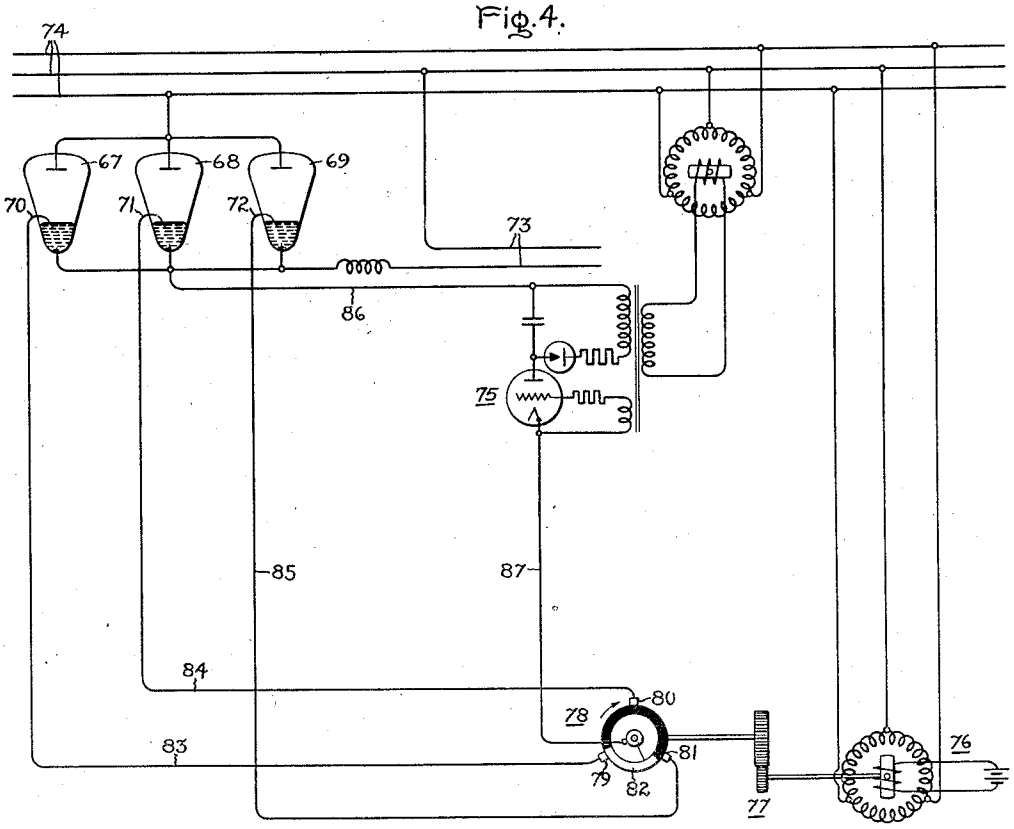
Inventor:
Ernst F. W. Alexanderson,
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ELECTRIC VALVE CIRCUITS

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Fig. 4.



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UNITED STATES PATENT OFFICE

2,104,633

ELECTRIC VALVE CIRCUITS

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Application April 15, 1936, Serial No. 74,462

16 Claims. (Cl. 175—363)

My invention relates to electric valve circuits and more particularly to control circuits for electric valve means of the type employing ionizable mediums such as gases or vapors.

Heretofore, in electric valve circuits where it has been desirable or necessary to increase the current carrying capacity of electric valve apparatus, the arc discharge paths have been interconnected through suitable current dividing means such as inductive reactances. Although these arrangements for increasing the current carrying capacity of an electric valve aggregate have proved satisfactory, there has been evidenced a decided need for inexpensive and simple arrangements for increasing the capacity of electric valve aggregates by utilizing the substantially greater short-time or momentary current ratings of the arc discharge means. Particularly, in connection with electric valve means of the type employing mercury pool cathodes and immersion-ignitor control members, it has become apparent that it is highly desirable to utilize the larger short-time or momentary current ratings of the individual arc paths.

It is an object of my invention to provide a new and improved electric valve control circuit which is simple and reliable in operation and which affords the above-mentioned advantages.

It is another object of my invention to provide a new and improved control circuit for electric valve discharge means to increase the continuous current carrying capacity of an electric valve aggregate.

It is a further object of my invention to provide a new and improved arrangement for increasing the continuous current rating of an electric valve aggregate of the type employing mercury pool cathodes and immersion-ignitor control members.

In accordance with the illustrated embodiments of my invention, I provide control circuits for increasing the current carrying capacity of a plurality of electric valves of the immersion-ignitor type by connecting the electric valves in electric circuits which are connected in parallel across the same points of potential difference and causing the individual arc paths to conduct current in a predetermined order to utilize the substantially greater short-time or momentary intermittent current ratings. In one embodiment of my invention, a pair of individual arc paths are rendered conductive alternately and thereby caused to conduct current alternately by means of an electro-mechanical device which energizes the individual immersion-ignitor control members alternately. In another embodiment of my invention, a pair of parallel-connected arc discharge paths are alternately rendered conductive by means of a pair of excitation circuits each associated with a different one of the individual associated control members. Both excitation circuits are energized from an auxiliary source of potential of a frequency and phase relation so correlated to the potential of an associated circuit to cause the arc discharge paths to conduct current alternately. In still another embodiment of my invention three electric valves are connected in parallel and are caused to conduct current in a predetermined order, each electric valve conducting for a predetermined number of positive half cycles.

For a better understanding of my invention, reference may be had to the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the accompanying drawings, Fig. 1 diagrammatically represents an embodiment of my invention as applied to a pair of electric valves which are rendered conductive alternately by means of an electro-mechanical device and an associated excitation circuit; Fig. 2 diagrammatically shows another embodiment employing an arrangement entirely electrical in construction and operation for rendering a pair of parallel-connected electric valves alternately conductive; Fig. 3 represents certain operating charactertistics of the arrangement shown in Fig. 2; and Fig. 4 diagrammatically shows an arrangement in which three electric valves are connected in parallel and rendered conductive sequentially.

Referring now to Fig. 1 of the accompanying drawings, my invention is diagrammatically shown as applied to an electric valve translating apparatus for interconnecting an alternating current supply circuit 1 and a direct current load circuit 2. Electric valve means including a pair of similarly disposed electric valves 3 and 4, having anodes 5 and 6, mercury pool cathodes 7 and 8, immersion-ignitor control members 9 and 10 and individual arc discharge paths, are connected directly in parallel across the same points of potential difference, a conductor 11 being employed to connect the anodes 5 and 6 together and a conductor 12 being used to connect the cathodes 7 and 8 together. Therefore, the potentials impressed on electric valves 3 and 4 are in phase with each other. A smoothing reactor 13 is connected in series with the electric valves 3 and 4.

In order to supply a suitable excitation cur-

rent to the control members 9 and 10, I employ a suitable excitation circuit 14 including a serially-connected capacitance 15 and a control electronic discharge means 16 having a control member 17, and a transformer 18 having a primary winding 19 and secondary windings 20 and 21. The secondary winding 20 serves to energize the capacitance 15 through a resistance 22 and a unidirectional conducting device 22'. The conductivity of electronic discharge means 16 is controlled through the control member 17 by means of the secondary winding 21 which impresses a suitable control potential on control member 17 through a resistance 23. The transformer 18 is shown as being energized from the alternating current circuit 1 through any conventional phase shifting device such as the rotary phase shifter 24.

To control the electric valves 3 and 4 so that these valves conduct current alternately, I may employ any suitable means. For the purpose of explaining my invention, I have diagrammatically shown an electro-responsive device 25 of the polarized type, having a core member 26, a polarized armature member 27 on which is mounted a movable contact 28, stationary contacts 29 and 30, and actuating windings 31 and 32 associated with the core member 26. The winding 31 is arranged to move the armature member 27 to the right so that contact 28 engages contact 30, and the winding 32 is arranged to move the armature 27 so that contact 28 engages contact 29. An over-center spring 27' is employed to bias the armature 27 to either the right-hand position or the left-hand position so that, when at rest, the movable contact 28 engages either stationary contact 30 or contact 29. The upper plate of capacitance 15 and the upper terminal of secondary winding 20 of transformer 18 are connected to cathodes 7 and 8 of electric valves 3 and 4 through conductors 33 and 12, and the electronic discharge means 16 is connected to the armature member 27 and hence to the movable contact 28 of device 25 through a conductor 34. The upper terminals of actuating windings 31 and 32 are connected to stationary contacts 29 and 30, and the lower terminals of these windings are connected to control members 9 and 10 of electric valves 3 and 4 through conductors 35 and 36 respectively.

The operation of the embodiment of my invention diagrammatically shown in Fig. 1 may be best explained by considering the arrangement when unidirectional current is being supplied to the direct current load circuit 2 through electric valves 3 and 4. Let it be assumed that the armature member 27 of device 25 is in the left-hand position so that the movable contact 28 is in contact with the stationary contact 29. Furthermore, let it be assumed that the capacitance 15 has been charged. During the positive half cycle of potential of circuit 1, the electronic discharge device 16 will be rendered conductive by secondary winding 21 effecting discharge of the capacitance 15 through a circuit comprising electronic discharge device 16, conductor 34, armature member 27, movable contact 28, stationary contact 29, actuating winding 31, conductor 35, control member 9, cathode 7, and conductors 12 and 13. By virtue of this discharge current, the arc discharge path of electric valve 3 will be rendered conductive. Since the actuating winding 31 is arranged to move the armature member 27 to the right-hand position, the movable contact 28 will engage the stationary contact 30.

During the following negative half cycle of potential of circuit 1, the capacitance 15 will be charged by means of winding 20 of transformer 18. At the predetermined time during the subsequent positive half cycle, electronic discharge means 16 will again be rendered conductive to effect energization of control member 10 of electric valve 4. The discharge current will also energize winding 32 to move armature 27 so that contact 28 again engages stationary contact 29. In this manner, the electric valves will conduct current one at a time, each valve conducting during alternate positive half cycles of potential of circuit 1.

Referring now to Fig. 2, my invention is diagrammatically shown as applied to electric valve translating apparatus for interconnecting an alternating current circuit and a direct current circuit. Electric valves 37 and 38, having anodes 39 and 40, mercury pool cathodes 41 and 42, immersion-ignitor control members 43 and 44 and each having an arc discharge path, supply unidirectional current to a direct current circuit 45 from an alternating current circuit 46. The anodes 39 and 40 and the cathods 41 and 42 of electric valves 37 and 38 are connected in parallel across the same points of potential difference by conductors 47 and 48 respectively. The immersion-ignitors 43 and 44 are energized by means of excitation circuits 49 and 50 respectively. Each of the excitation circuits 49 and 50 is provided with a capacitance 51, a resistance 52 and a control electronic discharge means 53 having a control member 54. The excitation circuits 49 and 50 are energized from a transformer 55 having secondary windings 56 and 57.

In order to control the conductivity of electronic discharge device 53 in accordance with an electrical condition, such as the voltage of circuit 46, I employ a circuit 58 including a transformer 59, suitable biasing means such as a battery 60, and current limiting resistances 61. Any conventional phase shifting arrangement well known in the art, such as the rotary phase shifter 62, may be employed to provide means for controlling the phase of the voltage impressed on the control members 54 of electronic discharge means 53.

To control the electric valves 37 and 38, I energize the transformer 55 from a circuit of alternating potential 63 correlated in frequency and phase to the potential of the employed phase of the circuit 46 so that the excitation circuits 49 and 50 render these valves conductive alternately. The period of conduction of each valve depends, of course, on the characteristics of the circuit 45 and the time during each positive half cycle of potential when the valve is rendered conductive. For the purpose of explaining my invention, I have chosen to energize the circuit 63 from the alternating current circuit 46 through any conventional frequency changing arrangement such as the synchronous motor 64 and a direct-connected alternating current generator 65, designed to supply an alternating potential of a frequency equal to one half that of the alternating current circuit 46. Any conventional phase shifting arrangement, such as the rotary phase shifter 66, may be interposed between the generator 65 and transformer 55 to adjust the phase of the potentials impressed on the excitation circuits 49 and 50.

The principles of operation of the embodi-

ment of my invention diagrammatically shown in Fig. 2 may be best explained by considering the operating characteristics shown in Fig. 3. Let the potential impressed on the anodes 39 and 40 of electric valves 37 and 38 be represented by curve A of Fig. 3, and the potentials impressed on excitation circuits 49 and 50 by secondary windings 56 and 57 of transformer 55 may be represented by curves B and C respectively. Curves D and E represent the current conducted by electric valves 37 and 38 respectively. The curve A also represents the potentials impressed on the control members 54 of electronic discharge devices 53.

Let it be assumed that at the time represented by the point *a* the electronic discharge device 53 of excitation circuit 49 is rendered conductive by the associated control member 54. Since the right-hand plate of capacitance 51 in excitation circuit 49 has been charged positively, an impulse of current will be transmitted through electronic discharge device 53 to the control member 43, cathode 41 of electric valve 37, and returned to capacitance 51. Electric valve 37 will, therefore, conduct unidirectional current, represented by curve D, to the load circuit 45. The electric valve 38 will not be rendered conductive at time *a* since the potential impressed on excitation circuit 50 by secondary winding 57 is negative, as represented by curve C, and because of the unidirectional conducting characteristics of the excitation circuit the control member 44 of electric valve 38 will not be energized.

During the interval *b*—*c* no current will be conducted by either electric valve 37 or electric valve 38. At time *c*, electric valve 38 will be rendered conductive by excitation circuit 50, and due to the fact that the potential impressed on excitation circuit by winding 56 of transformer 55 is negative at this time electric valve 37 will be maintained non-conductive. In this manner, electric valves 37 and 38 will conduct current alternately during positive half cycles of the potential impressed on the anodes of these valves.

While I have explained my invention as applied to an electric valve translating circuit for transmitting energy between an alternating current circuit and a direct current circuit, it is to be noted that by employing oppositely disposed groups of parallel connected electric valves, my invention may also be applied to arrangements for transmitting energy between alternating current circuits.

Fig. 4 of the accompanying drawings diagrammatically represents another embodiment of my invention in which three electric valves are connected in parallel and are rendered conductive sequentially. Electric valves 67, 68, and 69, having control members 70, 71, and 72, are connected in circuits which are connected in parallel across the same points of potential difference to supply unidirectional current to a direct current load circuit 73 from an alternating current circuit 74. An excitation circuit, similar to excitation circuit 14 of Fig. 1, is employed to supply suitable electrical impulses to the control members 70—72, inclusive. The excitation circuit 75 is selectively connected to the control members 70—72 through any suitable means which for the purpose of explaining my invention I have chosen to represent diagrammatically as a distributor arrangement including a synchronous motor 76 energized from the alternating current circuit 74, a reduction gear train 77 and a mechanical distributor 78, having brushes 79, 80, and 81, and a conducting segment 82. Brushes 79, 80, and 81 are connected to control members 70, 71, and 72 of electric valves 67, 68 and 69 through conductors 83, 84, and 85, respectively. Cathodes of electric valves 67, 68, and 69 are connected to the excitation circuit 75 through a conductor 86, and the excitation circuit is connected to the distributor 78 through a conductor 87.

The operation of the embodiment of my invention shown in Fig. 4 may be explained by considering the arrangement when unidirectional current is being supplied to the direct current circuit 73 by the electric valves 67, 68, and 69. Let it be assumed that it is desired to render the electric valves conductive in the following sequences: 67, 68, 69, and let it be further assumed that it is desirable to maintain each valve conductive for three consecutive positive half cycles. This operation may be effected by choice of the proper gear ratio, etc. With the distributor in the position shown, conducting segment 82 is in engagement with brush 79 to connect excitation circuit 75 to control member 70 of electric valve 67. Excitation circuit 75 will supply a suitable excitation current to control member 70 at the beginning of each positive half cycle for three consecutive cycles. The phase of the excitation current may be retarded relative to the anode-cathode potential if voltage control is desired. In a similar manner, control members 71 and 72 of electric valves 68 and 69 will be energized to render these valves conductive in a predetermined order, each valve conducting during three consecutive positive half cycles.

While I have shown and described my invention as applied to a particular system of connections and as embodying various devices diagrammatically shown, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention, 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 supply circuit, a load circuit, an electric translating circuit interconnecting said circuits including a plurality of parallel-connected electric circuits, a plurality of similarly disposed arc discharge paths associated with said parallel-connected circuits and each including a plurality of electrodes, said parallel-connected electric circuits being connected in said translating circuit so that the potentials impressed on corresponding electrodes of said arc discharge paths are substantially in phase, and means for causing said arc paths to conduct current in a predetermined order.

2. In combination, a supply circuit, a load circuit, an electric translating circuit interconnecting said circuits including electric valve means having a plurality of electrodes and a plurality of associated arc discharge paths, corresponding electrodes of said arc discharge paths being connected across the same predetermined points of potential difference in said translating circuit and said arc discharge paths having intermittent current ratings substantially greater than continuous ratings, and means for causing said arc paths to conduct current in a predetermined order to increase the current conducted by said electric

valve means above the continuous rating of any of said arc discharge paths.

3. In combination, a supply circuit, a load circuit, an electric translating circuit interconnecting said circuits including electric valve means having a plurality of electrodes and a plurality of associated arc discharge paths connected directly in parallel relation and forming paths for the flow of current in the same direction from said supply circuit to said load circuit, and means for causing said arc paths to conduct current one at a time.

4. In combination, a supply circuit, a load circuit, an electric translating circuit interconnecting said circuits including electric valve means having a plurality of arc discharge paths connected directly in parallel relation and forming paths for the flow of current in the same direction from said supply circuit to said load circuit, and means for causing said arc paths to conduct current in succession.

5. In combination, a supply circuit, a load circuit, electric translating apparatus interconnecting said circuits including electric valve means having a pair of arc discharge paths, said arc discharge paths being directly connected in parallel forming alternate paths for the flow of current in the same direction from said supply circuit to said load circuit and having intermittent current ratings substantially greater than continuous ratings, and means for causing said arc paths to conduct current alternately to increase the current conducted by said electric valve means above the continuous rating of either of said arc discharge paths.

6. In combination, a supply circuit, a load circuit, an electric translating circuit interconnecting said circuits including electric valve means having a plurality of arc discharge paths connected in parallel relation across the same points of potential difference in said translating circuit and being arranged to conduct current in the same direction, and means for causing said arc paths to conduct current sequentially and for rendering each valve conductive for a predetermined interval.

7. In combination, a supply circuit, a load circuit, an electric translating apparatus interconnecting said circuits including electric valve means having two arc discharge paths and each connected across the same points of potential difference in said translating circuit to conduct current in the same direction, an excitation circuit for said electric valve means, and means for alternately initiating discharges in said arc paths through said excitation circuit.

8. In combination, an alternating current circuit, a direct current circuit, an electric translating circuit interconnecting said circuits including electric valve means each having an arc discharge path and a control member therefor, said arc discharge paths being directly connected in parallel to conduct current in the same direction and being connected across the same points of potential difference in said translating circuit an excitation circuit for energizing said control members, and means for alternately connecting said excitation circuit to the associated control members of said electric valve means.

9. In combination, an alternating current circuit, a direct current circuit, an electric translating circuit interconnecting said circuits including electric valve means having two arc paths and individual control members therefor, said arc discharge paths being connected across the same points of potential difference in said translating circuit to conduct current in the same direction, an excitation circuit for energizing said control members comprising an electronic discharge device, and means for connecting said excitation circuit alternately to said control members during alternate half cycles of potential of the same predetermined sign.

10. In combination, an alternating current circuit, a direct current circuit, an electric translating circuit interconnecting said circuits including electric valve means having two arc discharge paths and individual control members therefor, said arc discharge paths being connected directly in parallel across the same points of potential difference in said translating circuit, an excitation circuit including a source of alternating potential, a capacitance connected to be charged from said source and means for discharging said capacitance at a predetermined time during each cycle of potential of said source, and means for connecting said excitation circuit alternately to said control members during alternate positive half cycles of potential of said alternating current circuit.

11. In combination an alternating current circuit, a direct current circuit, electric translating apparatus interconnecting said circuits including electric valve means having a pair of arc discharge paths and individual control members therefor, said arc paths being directly connected in parallel relation and forming alternate paths for current flow between said alternating current circuit and said direct current circuit, an excitation circuit including a source of alternating potential, a capacitance connected to be charged from said source and means for periodically discharging said capacitance, and means for alternately energizing said control members from said excitation circuit to cause said arc paths to conduct current alternately.

12. In combination, a supply circuit, a load circuit, an electric translating circuit interconnecting said circuits including electric valve means having a pair of arc discharge paths and individual control members associated therewith, said arc paths being connected in parallel forming alternate paths for current flow in the same direction and connected between the same points of potential difference in said translating circuit, an auxiliary source of alternating potential, a plurality of excitation circuits connected to be energized from said auxiliary source, and means for controlling said excitation circuits to cause said arc paths to conduct current alternately.

13. In combination, a supply circuit, a load circuit, an electric translating circuit interconnecting said circuits including electric valve means having a pair of arc discharge paths and individual control members associated therewith, said arc paths being similarly disposed and being directly connected in parallel across the same points of potential difference in said translating circuit, an auxiliary source of alternating potential, and a plurality of excitation circuits each associated with a different one of said control members and each connected to be energized from said auxiliary source, each of said excitation circuits comprising a capacitance arranged to be charged from said auxiliary source and an electronic discharge means for discharging said capacitance at predetermined intervals relative to the potential of said supply circuit.

14. In combination, an alternating current circuit, a direct current circuit, electric translating

apparatus interconnecting said circuits including electric valve means having a pair of arc discharge paths and individual control members associated therewith, said arc paths being connected in parallel across the same points of potential difference to conduct direct current alternately in the same direction from said alternating current circuit, an auxiliary source of alternating potential, a pair of excitation circuits each associated with a different one of said control members and each having electronic discharge means for controlling the energization of said associated control member, and means for controlling said electronic discharge means to cause said arc discharge paths to conduct current alternately.

15. In combination, an alternating current circuit, a direct current circuit, an electric translating circuit interconnecting said circuits including electric valve means having a pair of arc discharge paths and individual control members associated therewith, said arc paths being connected in parallel across the same points of potential difference in said translating circuit to supply unidirectional current to said direct current circuit, an auxiliary source of alternating potential of a frequency different from that of said alternating current circuit, a pair of excitation circuits each associated with a different one of said control members and each having an electronic discharge means for controlling the associated excitation circuit, and means energized from said alternating current circuit for controlling said electronic discharge means and being so correlated with the potential of said auxiliary source to cause said arc paths to conduct current alternately during predetermined recurring intervals.

16. In combination, an alternating current circuit, a direct current circuit, an electric translating circuit interconnecting said circuits including electric valve means each having a pair of arc discharge paths and individual control members associated therewith, said arc paths being connected in parallel across the same points of potential difference in the translating circuit to supply unidirectional current to said direct current circuit, an auxiliary source of alternating potential of a frequency equal to half that of said alternating current circuit, and a pair of excitation circuits energized from said auxiliary source each associated with a different one of said control members and each having means for controlling the associated excitation circuit to cause said arc paths to conduct current alternately.

ERNST F. W. ALEXANDERSON.

CERTIFICATE OF CORRECTION.

Patent No. 2,104,633. January 4, 1938.

ERNST F. W. ALEXANDERSON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 27, for "cathods" read cathodes; page 4, first column, line 66, claim 8, after the word "circuit" first occurrence, insert a comma; and second column, line 26, claim 11, after "combination" insert a comma; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 22nd day of February, A. D. 1938.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)