

H. W. LORD

ELECTRIC CIRCUITS

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Fig. 1.

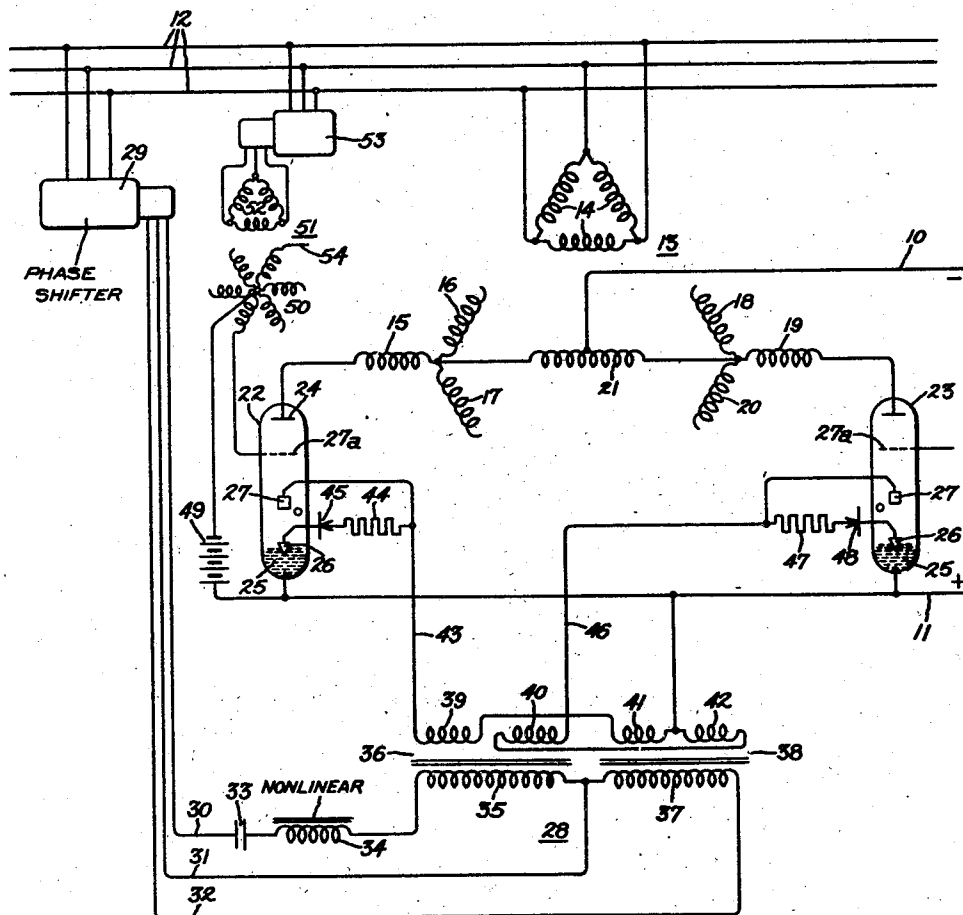
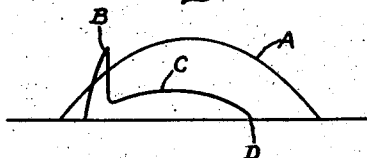


Fig. 2.



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ELECTRIC CIRCUITS

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My invention relates to electric valve circuits and more particularly to control or excitation circuits for electric valve apparatus of the type employing an ionizable medium capable of supporting an arc discharge.

In the control of electric valve apparatus employing an ionizable medium and a cathode of conducting liquid, such as mercury, it has been common practice to provide ignition means, such as an immersion-ignitor control member, which is energized by a current impulse to form a cathode spot and render the electric valve means conductive at a predetermined instant in the anode-cathode voltage wave. In order to prolong the life of the control member, it has been found desirable in some instances to provide auxiliary or additional electrodes to which the ignition current is transferred as soon as the arc discharge is initiated. In accordance with the teachings of my invention, I provide new and improved circuits for application to electric valve means of the above type wherein precision and reliability in the starting of the electric valve means and the assumption of load thereby is assured.

It is an object of my invention to provide new and improved electric valve circuits.

It is another object of my invention to provide new and improved control or excitation circuits for electric valve apparatus wherein the duty imposed on the starting or ignition means is substantially reduced and wherein the reliability of control and assumption of load by the electric valve means is not impaired.

In accordance with the illustrated embodiment of my invention, I provide an improved excitation circuit for supplying current impulses to electric valve means having control members of the make-alive type in which means are provided for relieving the control member of current-carrying duty as soon as a cathode spot is formed. In order to insure the assumption of load by the electric valve means when the current impulses supplied to the control member are of very short duration, I provide an auxiliary electrode connected with a point on the excitation circuit which is energized by a component of voltage having a long period compared with the duration of the current impulse supplied to the control member. This permits the use of grid control in combination with the make-alive electrodes.

My invention will be better understood by reference to the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims. In the drawing, Fig. 1 is a schematic representa-

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tion of one embodiment of my invention and Fig. 2 represents certain operating characteristics of the circuit of Fig. 1.

Referring now to Fig. 1 of the drawing, I have shown my invention applied to an electric valve translating system for energizing a direct-current load circuit, comprising conductors 10 and 11, from an associated alternating-current supply circuit 12 through electric translating apparatus comprising a transformer 13 having a primary winding 14 and two groups of secondary windings 15, 16, 17 and 18, 19, 20, respectively. The two groups of secondary windings may be interconnected through an interphase transformer 21 to cause the system to operate as a double three-phase or double Y system. The translating apparatus also includes a plurality of electric valve means which are connected respectively to the terminals of secondary windings 15 to 20, inclusive. Only electric valves 22 and 23, which are connected to the secondary windings 15 and 19, are shown in the drawing. The electric valves 22 and 23 are preferably of the type comprising an ionizable medium, such as a gas or vapor, capable of supporting an arc discharge and each includes an anode 24, a cathode 25 of the self-reconstructing type, an immersion-ignitor control member 26, a transfer or relieving electrode 27 and a control member or grid 27a. The control members 26 are formed of relatively high-resistance material with respect to the resistivity of the cathode and require the passage of a predetermined minimum current therethrough to establish a cathode spot.

I provide an improved excitation circuit for supplying impulses of current to the control members 26 and for energizing the auxiliary electrodes 27 for a substantial portion of the positive half wave of voltage of the anode-cathode circuit. The excitation circuit illustrated generally by the numeral 28 is energized from the supply circuit 12 through a suitable phase-shifting device 29. The output conductors 30, 31, and 32 provide a three-phase system of voltages which may be adjusted in phase with respect to the voltages of the circuit 12. Energized from the conductors 30 and 31 is a series circuit including the capacitor 33, a nonlinear or self-saturating reactor 34, and the primary winding 35 of a transformer 36. An alternating voltage substantially 120 electrical degrees out of phase with the voltage of conductors 30 and 31 is impressed on the primary winding 37 of a transformer 38. The transformer 36 is provided with secondary windings 39 and 40 and the transformer 38 is provided with secondary

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windings 41 and 42. The control member and auxiliary electrode of the electric valves 22 and 23 are energized from the secondary windings 39 to 42 in the following manner. One terminal of each of the windings 41 and 42 is connected with the conductor 11 of the direct-current circuit which interconnects the cathodes 25 of the electric valves 22 and 23. The other terminal of winding 41 is connected through winding 39 to the conductor 43 which is connected directly to the relieving anode 27 and to the control member 26 through a transfer resistance 44 and a unilaterally conducting device 45 which insures only unidirectional current flow through the control member. Similarly, the other terminal of winding 42 is connected through winding 40 to the conductor 46 which is connected directly to the relieving anode 27 of electric valve 23 and to the control member 26 of valve 23 through a transfer resistance 47 and a unilaterally conducting device 48. In order to delay the conduction of the electric valve means after the control members 26 thereof are energized, I provide a source of negative biasing potential such as battery 49 for maintaining the control members 27a at a negative voltage. The instant at which the electric valve means are rendered conductive is determined by the voltage of the secondary windings 50 of a transformer 51 having the primary winding 52 thereof energized from the supply circuit 12 through a suitable phase-shifting device 53. As illustrated in the drawing, the cathodes of the electric valves are connected to the neutral of the transformer winding 50 through the biasing battery 49. Only the control member 27a of electric valve 22 has been shown connected with the transformer 50. It will be understood that the control member 27a of electric valve 23 will be connected to conductor 54 energized by a portion of the winding 50 displaced 180 electrical degrees with respect to the winding energizing the control member 27a of valve 22. The phase-shifting means 53 provides means for determining any point in the cycle of anode-cathode voltage at which the electric valve means is rendered conductive.

The circuit including capacitor 33, reactor 34, and the primary winding 35 of transformer 36 is a nonlinear resonant circuit with respect to the magnitude of the alternating-current supply circuit voltage. That is, at a predetermined time during each half cycle of supply circuit voltage, reactor 34 saturates and the circuit becomes substantially resonant. This causes impulses of current to flow through the winding 35 at a predetermined instant during each half cycle of voltage of the supply circuit. These impulses are impressed on control members 25 and relieving anodes 27 by secondary windings 39 and 40. The passage of the current impulses establishes a cathode spot and the current is then transferred to the relieving anodes 27, this transfer being aided by the voltage drop appearing across resistors 44 and 47. Inasmuch as the life of the ignitor is determined largely by the current-carrying duty imposed thereon, it is desirable to supply impulses of relatively short duration to the ignitor and to relieve them of current-carrying duty as soon as possible. In carrying this out, the period of energization of the control member and relieving electrode by the current impulses used for ignition has been reduced to such an extent that, in some instances, the electric valve has failed to assume load current or has otherwise failed to conduct properly and also prevents de-

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layed conduction by grid control. In order to overcome this, I impress on the excitation circuit a timed sinusoidal voltage displaced in phase with respect to the current impulses produced by the excitation circuit so as to maintain the auxiliary electrodes energized for a considerable portion of the half cycle during which the electric valve means is intended to conduct. This voltage is preferably of such a magnitude that it will not form a cathode spot by itself but will maintain sufficient current through the relieving anode to maintain the spot once the spot has been formed.

Certain operating conditions of the circuit illustrated in Fig. 1 are shown in Fig. 2. Referring to Fig. 2, curve A illustrates the anode-cathode voltage of one of the electric valve means, curve B illustrates the peaked voltage impressed on the ignitor control member 26, and curve C illustrates the voltage impressed on the auxiliary or relieving anode 27 during the interval that the cathode spot is maintained thereby. It will be readily appreciated that, with these conditions, the conduction of the electric valves may be initiated any time after the cathode spot has been formed by the current impulse B until the current of the relieving anode 27 is reduced to zero as at D.

In the particular embodiment illustrated, the voltage for maintaining the auxiliary or relieving anode energized is displaced 120 electrical degrees with respect to the voltage impressed on the impulse-generating circuit. It will be readily understood that this displacement may be varied to extend the period of energization of the relieving anode to any amount desired for a particular installation.

While I have shown and described a particular embodiment of my invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from my invention in its broader aspects 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, an alternating-current supply circuit, a load circuit, electric translating apparatus interconnecting said circuits and comprising electric valve means including an anode, a cathode, arc-ignition means, and a relieving anode, an excitation circuit connected to said ignition means and a connection between a point on said excitation circuit and said relieving anode, said excitation circuit including a saturating reactance element which is saturable at a predetermined point in the voltage wave of said alternating current circuit to produce an impulse of current through said excitation means to establish a cathode spot, and means independent of said peak-producing reactance element for impressing on said excitation circuit a voltage having a predetermined timed relationship with respect to said peak and a substantially greater duration than the duration of said peak, the connection between said excitation circuit and said relieving anode being effective to transfer the current from said excitation means to said relieving anode upon the formation of a cathode spot.

2. In combination, an alternating-current circuit, a load circuit, electric translating apparatus connected between said circuits and comprising electric valve means including an anode, a cathode, arc-ignition means, and a relieving anode,

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an excitation circuit energized from said alternating-current circuit and comprising means for producing a peaked voltage and an alternating-current voltage of fundamental frequency which is displaced in phase with respect to the voltage impressed on said means for producing a peaked voltage, and means for impressing the sum of said voltages on said ignition means to produce a cathode spot, and a connection with said relieving anode for transferring current from said ignition means to said relieving anode upon the formation of a cathode spot to maintain an arc discharge in said valve means for a predetermined portion of the positive half wave of anode-cathode voltage thereof.

3. In combination, an electric valve means including an anode, a cathode, arc-ignition means, a relieving anode, and a control member, means for energizing the anode-cathode circuit of said electric valve means, an excitation circuit comprising means for producing a peaked voltage and a voltage having a predetermined timed relationship with respect to said peaked voltage and a substantially greater duration than said peaked voltage, means for impressing said peaked voltage on said ignition means to produce a cathode spot, means including a connection with said relieving anode for impressing the sum of said voltages on said relieving anode and for transferring current from said ignition means to said relieving anode, means for impressing a voltage on said control member to maintain said electric valve means nonconducting, and means for impressing a second voltage on said control member for overcoming said last-mentioned voltage to render said valve means conducting at a predetermined instant during the existence of said cathode spot.

4. In combination, an alternating-current circuit, a load circuit, electric translating apparatus connected between said circuits and comprising electric valve means including an anode, a cathode, arc-ignition means, a relieving anode, and a control member, an excitation circuit energized from said alternating-current circuit and comprising means for producing a peaked voltage and a voltage having a predetermined timed relationship with respect to said alternating-current circuit and a substantially greater duration than said peaked voltage, means for impressing the sum of said voltages on said ignition means to produce a cathode spot, a connection with said relieving anode for transferring current from said ignition means to said relieving anode, means for impressing a voltage on said control member to maintain said electric valve means nonconducting, and means for impressing a variable voltage on said control member to render said valve means conducting at a predetermined instant during the existence of said cathode spot.

5. In combination, an alternating-current supply circuit, a load circuit, electric translating ap-

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paratus connected between said circuits and comprising electric valve means including an anode, a cathode, a make-alive control electrode, and a relieving anode, means connecting said control electrode and said relieving anode electrically together to provide a terminal, means supplying a current impulse to said terminal at a predetermined time in the alternating-current voltage wave of said supply circuit comprising a nonlinear resonant circuit energized from said supply circuit, and means for impressing between said terminal and said cathode a periodic voltage of substantially greater duration than said current impulse and displaced in phase with respect to the voltage impressed on said nonlinear resonant circuit.

6. In combination, a polyphase alternating-current circuit, a load circuit, electric translating apparatus connected between said circuit and comprising electric valve means including an anode, a cathode, arc-ignition means, and a relieving anode, means connecting said arc-ignition means and said relieving anode electrically together to provide a terminal, peaked voltage-producing means energized from one phase of said alternating-current circuit and connected to supply an impulse of current to said common terminal, and means for impressing between said terminal and the cathode of said electric valve means a timed voltage with respect to said current impulse, said last-mentioned means being energized from a different phase of said alternating-current circuit from said peaked voltage-producing means.

7. In combination, a polyphase alternating current circuit, a load circuit, electric translating apparatus connected between said circuits and comprising electric valve means including an anode, a cathode, arc-ignition means, and a relieving anode, means connecting said arc-ignition means and said relieving anode electrically together to provide a terminal, peaked voltage-producing means energized from one phase of said alternating current circuit and connected to supply an impulse of current to said common terminal, and means for impressing between said terminal and the cathode of said electric valve means a timed voltage with respect to said current impulse.

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