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ELECTRIC VALVE CIRCUIT

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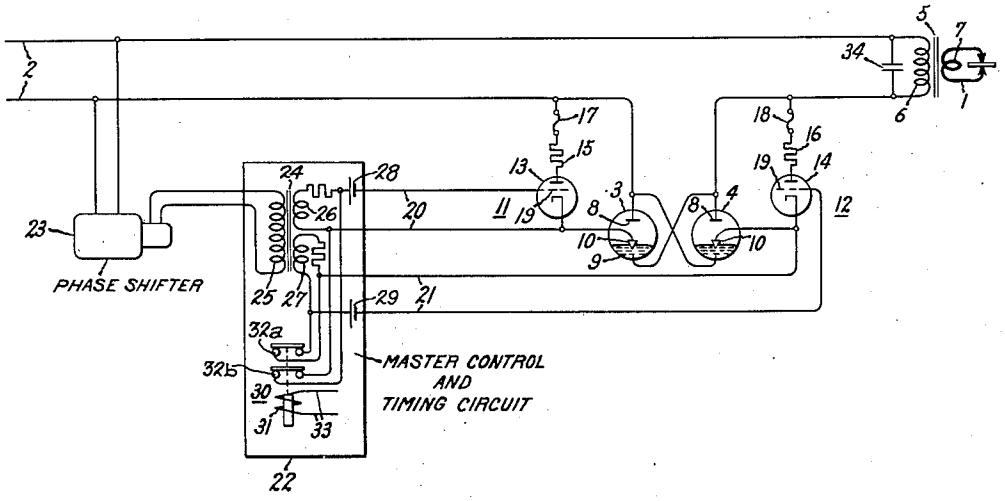

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ELECTRIC VALVE CIRCUITS

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6 Claims. (Cl. 250—27)

My invention relates to electric valve circuits and more particularly to control circuits for electric valve apparatus of the type employing an ionizable medium, such as a gas or a vapor.

Electric valve means of the type employing an ionizable medium, such as a gas or a vapor and utilizing a control member of the immersion-igniter type associated with the cathode have found rather general application in systems which are required to deliver current of predetermined magnitude to a load circuit, such as a welding circuit, from an alternating current supply circuit. Various types of control or excitation circuits have been provided for electric valve equipment of this nature. One type of circuit rather generally employed is that in which the excitation circuit is responsive to the anode voltage of the associated electric valve, and wherein the energizing or ignition current for the electric valve means is derived from the supply circuit. In accordance with the teachings of my invention described hereinafter, I provide a new and improved circuit wherein the range of operation of control or excitation circuits of this nature and the flexibility of control are substantially increased.

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

It is another object of my invention to provide a new and improved electric control or excitation circuit for electric valve means of the type employing an ionizable medium and using an immersion-igniter control member.

Briefly stated, in the illustrated embodiment of my invention I provide a new and improved excitation circuit for electric valve translating systems which may comprise a pair of reversely connected electric valves connected between an alternating current supply circuit and a transformer which in turn is connected to the load circuit. Anode-type starting or excitation circuits are connected between the anodes of each of the electric valve means and the associated immersion-igniter control member and are provided with rectifiers or electric discharge devices which are controlled to transmit excitation or ignition current to the control members at predetermined times during a cycle of voltage of the supply circuit, and to control thereby the conductivity of the electric valve means and control the amount of current transmitted to the load circuit. An impedance element such as a capacitance is connected in series relation with the anode-cathode circuits of the electric valve means and preferably connected across at least a portion of the primary winding means to obtain a substantially low impedance path to the flow of ignition or excitation current, thereby assuring the transmission of the predetermined critical minimum value of current to the control members irrespective of the impedance of the load circuit and irrespective of the time during the cycle at which the electric discharge devices are rendered conducting.

For a better understanding of my invention, reference may be had to the following drawing taken in connection with the accompanying drawing, and its scope will be pointed out in the appended claims. The single figure of the drawing diagrammatically illustrates an embodiment of my invention as applied to an electric valve system for energizing a welding circuit.

Referring now to the single figure of the drawing, I have there illustrated my invention as applied to an electric valve translating system for energizing a variable impedance load circuit 1, such as a welding circuit, from an alternating current supply circuit 2 through a pair of reversely connected electric valve means 3 and 4 and a transforming means, such as a transformer 5, having primary winding means 6 and secondary winding means 7 connected to the load circuit 1.

The electric valve means 3 and 4 are each preferably of the type employing an anode 8, a cathode 9 and having an immersion-igniter control member 10 associated with the cathode 9. The cathode 9 may be a mercury pool into which the control member 10 extends. The control member 10 is constructed of a material such as boron carbide or silicon carbide which has an electrical resistivity substantially large compared with that of the associated mercury and is effective to initiate an arc discharge between the anode 8 and cathode 9 upon the transmission of a predetermined critical value of current to the control member. I provide excitation circuits 11 and 12 associated with electric valve means 3 and 4, respectively, and which are of the type responsive to the respective anode voltages of the electric valve means. Excitation circuits 11 and 12 comprise unidirectional conducting devices or rectifiers, such as electric discharge devices 13 and 14 which are connected to the anodes 8 of electric valve means 3 and 4 through resistances 15 and 16, respectively. If desired, fuses 17 and 18 may be connected in series relation with the electric discharge devices 13 and 14 to open and prevent operation of the excitation circuits in the

event the excitation current tends to exceed a predetermined value.

Electric discharge devices 13 and 14 may also be of the type comprising an ionizable medium and each of these discharge devices may comprise a control grid 19 which are normally biased to maintain the discharge devices nonconducting. The electric discharge devices are rendered conducting at predetermined times during predetermined cycles of voltage of supply circuit 2 by control and timing circuits 20 and 21. The control circuits 20 and 21 in turn may be energized from a master control and timing circuit 22 which may be energized from the alternating current supply circuit 2 through a suitable phase shifting means 23.

The control and timing circuit 22 may be any of the types now well known in the art and may control the system to effect intermittent energization of the load circuit 1 or to effect a single energization of the load circuit for a predetermined number of half cycles of voltage of supply circuit 2.

For the purpose of diagrammatically illustrating my invention, I have chosen to show the timing circuit 22 as comprising a transformer 24 having a primary winding 25 and secondary windings 26 and 27 which are connected to control circuits 20 and 21, respectively. Suitable negative unidirectional biasing potentials may be impressed on the control grids 19 of the electric discharge devices 13 and 14 by batteries 28 and 29, respectively. Transformers 24, if desired, may be of the saturable type which induces in windings 26 and 27 voltages of peaked wave form in order that the discharge devices 13 and 14 are rendered conducting at precise instants during cycles of voltage of supply circuit 2. Energization of circuits 20 and 21 may be controlled by suitable means such as a relay 30 which is connected across the secondary windings 26 and 27 of transformer 24. The relay 30 may be provided with an actuating coil 31 and normally closed contacts 32*a* and 32*b* which are connected across the secondary windings 27 and 26 through current limiting resistances. The actuating coil 31 may be energized intermittently from circuit 33 to effect intermittent energization of the load circuit 1, or may be energized for a predetermined interval of time in response to a single circuit controlling operation to effect a single energization of the load circuit 1.

In order to provide a relatively low impedance path for the flow of excitation current to the control members 10 of electric valve means 3 and 4, irrespective of the impedance of the load circuit 1 and transformer 5 and irrespective of the time during the cycle of voltage of supply circuit 2 at which the electric discharge devices 13 and 14 are rendered conducting, I connect in circuit with control members 10 and electric discharge devices 13 and 14 a suitable impedance means such as capacitance 34 which may be connected across the primary winding means 6 of the transformer 5. If desired, of course, the capacitance 34 may be connected across only a portion of the primary winding means. In this manner positive ignition of electric valve means 3 and 4 is assured even though the electric valve system is operated within that region wherein the control voltages provided by circuits 20 and 21 are within the latter portion of the respective positive half cycles of anode-cathode voltage applied to electric valve means 3 and 4. The capacitance 34, by virtue of its nature, assures the transmission of sufficient current to the control members 10 and at the same time will, of course, prevent the transmission of an excessive amount of current since the current transmitted therethrough will decrease as the charge on the capacitance increases.

While I have chosen to represent the impedance means which is connected across the primary winding means as being a capacitance, it will be understood that other impedance means of suitable character may also be used in place of a capacitance. An important consideration is that the impedance of the path provided in series relation with the anode-cathode circuit of electric valve means 3 and 4 be of such value that the excitation current transmitted to control members 10 will be of sufficient magnitude to render the electric valve means conductive irrespective of the time during the positive half cycles of applied anode-cathode voltage at which the electric discharge devices 13 and 14 are rendered conductive. Of course, the only limitation on the region of the positive half cycles during which suitable excitation current is transmitted to the control members is the magnitude or value of voltage required to transmit the critical control member current. By providing a path in parallel with the primary winding means, a substantially greater current may be transmitted through the control member for the same value of anode-cathode voltage.

The operation of the embodiment of my invention shown in the single figure of the drawing will be explained by considering the system when it is operating to effect energization of the load circuit 1 from the supply circuit 2. More particularly, it will be assumed that it is desired to effect energization of the load circuit 1 for a predetermined number of half cycles of the voltage of supply circuit 2 in response to a single circuit controlling operation, such as that which will be obtained by energizing circuit 33 for a predetermined period of time.

Upon energization of actuating coil 31 of relay 30, contacts 32*a* and 32*b* of this relay are opened, causing the transmission of alternating voltages of peaked wave form to control circuits 20 and 21 from transformer 24. Electric discharge devices 13 and 14, which have previously been maintained nonconducting by virtue of the biasing potentials furnished by batteries 28 and 29, will now be rendered conducting at predetermined times established by the phase position of the voltages of peaked wave form.

If it be assumed that it is desired to transmit current of relatively small magnitude to the load circuit 1, the phase shifter 23 is adjusted so that the electric discharge devices 13 and 14 are rendered conducting within the latter portion of the respective positive half cycles of anode-cathode voltage applied to electric valve means 3 and 4. If it be assumed further that the discharge device 13 is rendered conducting first, a circuit is completed for the energization of the control member 10 of the electric valve means 3 through a circuit including the lower terminal of supply circuit 2, fuse 17, resistance 15, the anode-cathode circuit of electric discharge device 13, control member 10 and cathode 9 of electric valve means 3, capacitance 34 and the upper terminal of the supply circuit 2. It will, therefore, be appreciated that a path of predetermined impedance is provided to assure the transmission to

the control member 10 a current which is at least equal to the critical current required to initiate an arc discharge between the anode 8 and cathode 9 of electric valve means 3. Of course, during the succeeding half cycle of voltage of supply circuit 2 the control member 10 of electric valve means 4 will be energized through a corresponding circuit including the capacitance 34.

It will be appreciated that in this manner great accuracy may be obtained in control of the magnitude of the current transmitted to the load circuit 1, even though the system is adjusted to effect the transmission of only a relatively small current to the load circuit. In this manner, the range of application of anode-responsive type firing circuits for electric valve means employing immersion-igniter control members has been enlarged to permit application to that type of load which requires wide ranges of current control. Furthermore, the accuracy of load current control is not sacrificed.

The use of a capacitance in circuit with the anode-cathode circuits of the electric valve means 3 and 4, while it assures the transmission of the necessary or desired current to render the electric valve means conductive throughout substantially the entire positive half cycles of applied anode-cathode voltage irrespective of the phase setting or the phase position of the voltages of control circuits 20 and 21, also serves to prevent the transmission of excessive current to control members 10, or the transmission of current during an extended period of time to the control members. It will be appreciated that as the capacitance charges, the magnitude of the current which flows through either one of the control members 10 correspondingly decreases.

Another important advantage of my invention is the wide range of current control obtainable. If it be assumed that it is desired to transmit to the welding circuit 1 a current of relatively small magnitude where the impedance of the welding circuit is high, the phase shifter 23 may be adjusted to render the electric discharge devices 13 and 14 conducting near the beginning of the positive half cycles of anode-cathode voltage applied to electric valve means 3 and 4. Even though the impedance of transformer 5 and the welding circuit 1 are relatively large, under this assumed condition of operation, the impedance to the flow of ignition current to the control members is sufficiently low, by virtue of capacitance 34, to render the electric valve means 3 and 4 conductive. This is a decided advantage over the prior art arrangements where anode-type excitation circuits have been employed, because in the prior art arrangements the impedance of the load circuit materially limited the application of anode-type starting circuits.

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, an alternating current supply circuit, a load circuit, transforming means having primary winding means and secondary winding means connected to said load circuit, electric valve means connected between said primary winding means and said supply circuit and being of the type comprising an anode, a cathode, an immersion-igniter control member in contact with said cathode and employing an ionizable medium capable of supporting an arc discharge, an excitation circuit connected between said anode and said control member, means for controlling said excitation circuit to determine the time in a cycle of voltage of said supply circuit at which said control member is energized, and a capacitance connected across at least a portion of said primary winding means so that said control member is energized by the transient current flow through said capacitor to insure sufficient current through said control member to initiate conduction of said valve means independently of the time in the cycle of voltage of said supply circuit that said control member is energized.

2. In combination, an alternating current supply circuit, a load circuit, a transformer having primary winding means and secondary winding means connected to said load circuit, a pair of reversely connected electric valve means connected in series relation with said primary winding means and said supply circuit and each being of the type comprising an anode, a cathode, an immersion-igniter control member in contact with said cathode and employing an ionizable medium capable of supporting an arc discharge, a pair of anode responsive circuits each connected between the anode and the control member of a different one of said electric valve means and each comprising an electric discharge device having a grid, means for controlling said grids to render the discharge devices conducting at predetermined times during a cycle of voltage of the supply circuit, and a capacitance connected across at least a portion of said primary winding means so that the transient charging current of said capacitor flows through the control members to initiate conduction of said valve means irrespective of the impedance of said load circuit and said transformer and the time in the cycle that said control members are energized.

3. In combination, an alternating current supply circuit, a load circuit, transforming means having primary winding means and secondary winding means connected to said load circuit, electric valve means connected between said supply circuit and said primary winding means and being of the type comprising an anode, a cathode, an immersion-igniter control member in contact with said cathode and employing an ionizable medium capable of supporting an arc discharge, an excitation circuit connected between said anode and said control member and comprising an electric discharge device of the controlled type having a control grid for determining the time during a cycle of voltage of said supply circuit at which current is transmitted to said control member, and a capacitance connected across at least a portion of said primary winding means so that the transient charging current of said capacitor flows from said source through said electric discharge device, said control member and said cathode and insures initiation of conduction of said valve means regardless of the time in the cycle of voltage of the supply circuit that said control member is energized.

4. In combination, an alternating current supply circuit, a load circuit, a transformer having primary winding means and secondary winding means connected to said load circuit, a pair of reversely connected electric valve means con-

nected in series relation with said supply circuit and said primary winding means and being of the type comprising an anode, a cathode, an immersion-igniter control member in contact with said cathode and employing an ionizable medium capable of supporting an arc discharge, a pair of excitation circuits each associated with a different one of said electric valve means and each comprising an electric discharge device connected between the anode and the associated control member to transmit timed impulses of unidirectional current thereto for initiating arc discharges between the anodes and associated cathodes, the discharge devices each comprising a control grid, means for energizing the control grids to determine the time during a cycle of alternating voltage of said supply circuit at which said positive impulses of current are transmitted to said control members, and a capacitance connected across at least a portion of said primary winding means to provide a relatively low impedance path for the flow of excitation current to said control members irrespective of the impedance of said load circuit and said transformer to insure the supply of sufficient exciting current to said control members to initiate conduction of said electric valve means regardless of the time in the cycle of the voltage of the supply circuit that said control members are energized.

5. In combination, an alternating current supply circuit, a load circuit, transforming means having primary winding means and secondary winding means connected to said load circuit, electric valve means connected between said primary winding means and said supply circuit and being of the type comprising an anode, a cathode, an immersion-igniter control member in contact with said cathode and employing an ionizable medium capable of supporting an arc discharge, an excitation circuit connected between said anode and said control member, and impedance means connected in series relation with said supply circuit and said excitation circuit to provide a path for the flow of excitation current to said control member, the impedance of said path being substantially less than the impedance through said load circuit and of such a value as to pass sufficient excitation current to said control member to enable said valve to be rendered conductive over substantially the full range of instantaneous values of anode voltage in any given positive half cycle of said supply circuit.

6. In combination, an alternating current supply circuit, a load circuit, transforming means having primary winding means and secondary winding means connected to said load circuit, electric valve means connected between said primary winding means and said supply circuit and being of the type comprising an anode, a cathode, an immersion-igniter control member in contact with said cathode and employing an ionizable medium capable of supporting an arc discharge, an excitation circuit connected between said anode and said control member and comprising an electric discharge device, means for controlling the conductivity of said discharge device, and impedance means connected in series relation with said supply, said control member and said cathode, to provide a relatively low impedance path for the flow of excitation current to said control member irrespective of the time during the positive half cycles of applied anode-cathode voltage applied to said electric valve means at which said electric discharge device is rendered conductive.

LOUIS G. LEVOY, JR.