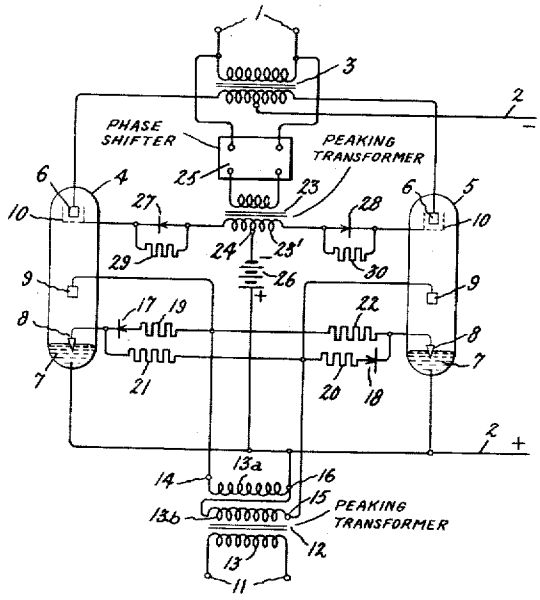
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ELECTRIC VALVE CIRCUIT

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ELECTRIC VALVE CIRCUIT

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15 Claims. (Cl. 315—195)

My invention relates to electric valve systems 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 employing self-reconstructing type cathodes, such as mercury pool cathodes, have been found to afford decided advantages in those applications where large amounts of current are transmitted by an associated load circuit. In accordance with the teachings of my invention described hereinafter, I provide new and improved electric control circuits for electric valve means of this type, and whereby greater accuracy in the control of the conductivity of the electric valve means is obtained.

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 control circuit for electric valve apparatus of the type comprising an ionizable medium capable of supporting an arc discharge.

It is a further object of my invention to provide a new and improved control or excitation circuit for controlling the conductivity of electric valve means using a self-reconstructing type cathode and which comprises ignition means such as an immersion-igniter control member associated with the cathode.

Briefly stated, in the illustrated embodiment of my invention I provide a new and improved control system for electric valve apparatus of the type which employs a self-reconstructing type cathode, such as a mercury pool cathode, and in which the time of initiation of current flow between the anode and cathode is accurately determinable by controlling the potential of an auxiliary control electrode or a baffle. Unidirectional impulses of current are transmitted to the ignition means, which may be an immersion-igniter control member in contact with the cathode, by means of a unidirectional conducting device, such as a dry rectifier or a copper-oxide type rectifier. In order to maintain the potential of the control member at the same potential as the cathode, thereby preventing transmission of appreciable inverse current between the cathode and the control member during the negative half cycles of voltage of the source of excitation current, I provide equalizing means connected between the source of alternating excitation current and the control member.

For a better understanding of my invention, reference may be had to the following description 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 a biphase rectifier and which comprises electric valve translating apparatus connected between an alternating current supply circuit and a direct current load circuit.

Referring now to the single figure of the drawing, I have there illustrated my invention as applied to an electric valve translating or converting system connected between an alternating current supply circuit 1 and a load circuit such as a direct current load circuit 2. The translating apparatus may include a transformer 3 and a pair of electric valve means 4 and 5 which operate as a biphase rectifier for transmitting unidirectional current to the load circuit.

Electric valve means 4 and 5 are preferably of the type employing an ionizable medium, such as a gas or a vapor, and each comprises an anode 6, a self-reconstructing cathode such as a mercury pool cathode 7, and ignition means which may be of the immersion-igniter type such as an immersion-igniter control member 8 constructed of a material, such as boron carbide or silicon carbide having an electrical resistivity substantially large compared with that of the mercury of the associated pool. An extremity of the immersion-igniter control member 8 may extend into the mercury. Each of the electric valve means 4 and 5 also may comprise a relieving or transfer anode 9. In order to control the times of initiation of current flow between the anodes 6 and the cathodes 7 after the initiation of arc discharges by control member 8, I provide baffle or control electrodes 10 which are preferably within the vicinities of the respective anodes 6, and which may be constructed to enclose substantially the anodes 6.

As a means for supplying excitation current to the control members 8 of electric valve means 4 and 5, I provide an excitation circuit which is energized from a suitable source of alternating current 11. The source of current for energizing the excitation circuit, of course, may be derived from the supply circuit 1 through suitable phase shifting means, if desired. I connect to the source 11 means for producing periodic or alternating voltages of peaked wave form. This means may comprise a transformer 12 having a primary winding 13 and winding means, such as a secondary winding, for supplying peaked alternating

voltages displaced substantially 180 electrical degrees with respect to each other. This secondary winding means may comprise winding sections 13a and 13b having electrically displaced terminal connections 14 and 15, and a connection 16 electrically intermediate the terminal connections. The intermediate connection 16 is connected to the cathodes 7 of electric valve means 4 and 5.

In order to transmit to the control members 8 of electric valve means 4 and 5 impulses of unidirectional current of peaked wave form and for initiating arc discharges within the electric valve means by establishing cathode spots upon the surface of the mercury pool cathodes 7, I provide rectifiers 17 and 18 which are preferably of the contact or dry type such as that disclosed and claimed in U. S. Letters Patent No. 1,640,335, granted August 23, 1927, upon an application of Lars O. Grondahl. Relieving anodes 9 are connected to the terminals 14 and 15, respectively, of winding sections 13a and 13b, and I connect transfer resistances 19 and 20 in series relation with the rectifiers 17 and 18 so that upon initiation of arc discharges within the respective electric valve means, the potential of the relieving anodes is substantially raised, thereby effecting the transmission of the greater portion of the excitation current from control members 8 to relieving anodes 9 and accordingly reducing the duty imposed on control members 8.

As a means for maintaining the control members 8 at substantially the same potentials as the associated cathodes 7 during the respective inverse half cycles of voltage of source 11 or, in other words, to prevent the flow of inverse current from cathodes 7 to control members 8 during the negative half cycles of voltage produced by winding sections 13a and 13b, I provide equalizing means connected to the winding sections 13a and 13b. This equalizing means may comprise resistances 21 and 22 which are connected between electrically displaced points of the secondary winding means of transformer 12 and the control members 8 of the electric valve means. The magnitude of the resistances 21 and 22 is preferably equal to the average inverse resistance of the dry rectifiers 17 and 18. More particularly, resistance 21 is connected between control member 8 of electric valve means 4 and the terminal 15 of winding 13b. In like manner, resistance 22 is connected between control member 8 of electric valve means 5 and the terminal 14 of the winding section 13a. Periodic voltages are impressed on the control electrodes 10 of electric valve means 4 and 5 in order to render the electric valve means conducting alternately, and to control the time during the cycles of voltage of circuit 1 at which current flow is initiated between the respective associated anodes 6 and cathodes 7. I provide a transformer 23 energized from a source of alternating current of the proper frequency. Transformer 23 comprises a secondary winding 23' having a neutral connection 24. If desired, transformer 23 may be energized from the alternating current circuit 1 through a phase shifting device 25. The phase shifting device 25 serves to control the phase of the periodic voltages impressed on control electrodes 10 and, hence, controls the magnitude of the current transmitted to the load circuit.

Suitable potential biasing means, such as a battery 26, may be connected between the cathode 7 and the neutral connection 24 of transformer 23 in order to impress on the control electrodes 10 a negative unidirectional biasing potential. I connect between the secondary winding 23' of transformer 23 means for assuring the transmission of sufficient positive control current to the electrodes 10, thereby assuring the positive initiation of arc discharges between associated anodes 6 and cathodes 7. This means may comprise unidirectional conducting devices or rectifiers 27 and 28 which are connected, respectively, in parallel with impedance elements such as resistances 29 and 30.

Transformer 23 may also be a peaking transformer, so that the impulses of postive current transmitted to the control electrodes 10 are of distinct or sharp wave form thereby increasing the precision of control of the electric valve means 4 and 5.

The operation of the embodiment of my invention illustrated in the single figure of the drawing will be explained by considering the system when it is operated as a biphase rectifier to transmit unidirectional current to the load circuit 2. The peaking transformer 12, by virtue of the windings 13a and 13b, transmits unidirectional impulses of current to the control members 8 of electric valve means 4 and 5 alternately at times displaced substantially 180 electrical degrees relative to the voltage of the circuit 1. These unidirectional impulses are transmitted to the control members 8 through the rectifiers 17, 18 and associated resistances 19, 20 respectively. Considering in particular the ignition of the electric valve means 4, upon the transmission of a unidirectional impulse of current to the control member 8 as soon as a cathode spot and incident ionization of the mercury vapor is obtained, the increased flow of current through the resistance 19 raises the potential of the relieving anode 9, thereby effecting the transfer of the greater portion of the ignition or exciting current from the control member 8 to the relieving anode 9. In this manner, the duty imposed on control member 8 is reduced. The relieving anode 9 maintains the arc within the electric valve means until such time as a suitable positive voltage is impressed on the control electrode 10, at which time the arc discharge is established between the anode 6 and the cathode 7.

Control electrodes 10 are normally maintained by the battery 26 at potentials sufficiently negative to prevent the propagation of the arc discharges to the anodes 6. At predetermined times established by the phase position of the periodic voltage of peaked wave form produced by transformer 23, the voltage produced by winding 23' attains a value which is sufficient to overcome the effect of the battery 26 and raises the potentials of control electrodes 10, thereby extending the arc discharges to the anodes 6. Referring particularly to electric valve means 4, at the time when a positive impulse of voltage of peaked wave form occurs, a unidirectional impulse of voltage is impressed on the control electrode 10 of electric valve means 4. This selective unidirectional energization of control electrode 10 is obtained by means of rectifier 27. In like manner, positive impulses of voltage of peaked wave form will be impressed on control electrode 10 of electric valve means 5 at intervals displaced 180 electrical degrees relative to the impulses impressed on electrode 10 of electric valve means 4.

Due to the parallel connection of rectifiers 27 and 28 and resistances 29 and 30, respectively, the positive impulses which are supplied to the electrodes 10 are of substantially greater magnitude than the negative impulses, thereby assur-

ing greater precision in control of electric valve means 4 and 5.

The amount of current transmitted by the electric valve converting system and the amount of current transmitted to load circuit 2 are controllable or adjustable by means of the phase shifter 25. As the phase of the impulses of voltage impressed on the control electrodes is advanced toward the beginning of the positive half cycles of anode-cathode voltage, the amount of current is correspondingly increased, and as the phase of the positive impulses is retarded the load current is decreased. It will be appreciated that the amount of current transmitted to the load circuit may also be determined by controlling the phase of the voltage produced by peaking transformer 12, in which case, however, it will be understood that the voltages impressed on control members 8 and control electrodes 10 must be in substantial phase coincidence, or the potentials impressed on control electrodes 10 must lag those impressed on control members 8.

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 circuit, a load circuit, electric translating apparatus connected between said circuits and comprising electric valve means including an anode, a cathode, a control member of the immersion-igniter type associated with said cathode and a control electrode within the vicinity of said anode, means for supplying to said control member a periodic voltage to establish a cathode spot, and means for supplying to said control electrode a periodic voltage of predetermined phase displacement relative to the voltage of said supply circuit and comprising in series relation with said control electrode a parallel connected unidirectional conducting device and a resistance.

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 and a control member of the immersion-igniter type associated with said cathode, and an excitation circuit for energizing said control member comprising a source of alternating current, transforming means energized from said source and including a winding section having a pair of terminals and an intermediate connection, said intermediate connection being connected to said cathode, means connected between one of said terminals and said control member and comprising a rectifier of the dry type for transmitting unidirectional current to said control member and a resistance connected between the other terminal and said control member.

3. 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 and a control member of the immersion-igniter type associated with said cathode, and an excitation circuit for energizing said control member comprising a source of alternating current, transforming means including a winding section having a pair of terminals and an intermediate connection, said intermediate connection being connected to said cathode, means connected between one of said terminal connections and said control member and comprising a rectifier of the dry type for transmitting unidirectional current to said control member and a resistance connected between the other terminal and said control member and having a value substantially equal to the average inverse resistance of said rectifier for maintaining said control member at cathode potential during the negative half cycles of voltage of said source.

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, a control member of the immersion-igniter type associated with said cathode and a transfer electrode, a source of alternating current comprising transforming means having a winding section provided with a pair of terminal connections and a connection intermediate said terminal connections, the intermediate connection being connected to said cathode, means for transmitting impulses of unidirectional current to said control member comprising a resistance and a dry rectifier connected between one of said terminals and said control member, means for connecting said transfer electrode to said one terminal, and means for maintaining said control member at cathode potential during inverse half cycles of voltage of said source and comprising a resistance connected between the other terminal and said control member, said resistance having a value equal to the average inverse resistance of said dry rectifier.

5. 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 of the mercury pool type, an immersion-igniter control member in contact with said cathode and a control electrode within the vicinity of said anode, a source of alternating current comprising transforming means having a winding section provided with a pair of terminals and a connection electrically intermediate said terminals for transmitting impulses of unidirectional current to said control member to establish arc discharges within said electric valve means and comprising a dry rectifier connected between one of said terminals and said control member, means for maintaining said control member at cathode potential during the inverse half cycles of voltage of said source and comprising a resistance connected between said control member and the other terminal, and means connected to said control electrode for determining the time during the cycles of voltage of said alternating current circuit at which current flow is initiated between said anode and said cathode.

6. 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, a control member of the immersion-igniter type associated with said cathode and a control electrode within the vicinity of said anode, means for supplying to said control member a periodic voltage of peaked wave form comprising a source of alternating current and a peaking transformer having winding means connected to said control

member, and means for supplying to said control electrode a periodic voltage of predetermined phase displacement relative to the voltage of the supply circuit and for controlling the time of initiation of current flow between said anode and said cathode and comprising a unidirectional conducting device and a resistance in parallel with said unidirectional conducting device.

7. 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, a control member of the immersion-igniter type associated with said cathode, a control electrode within the vicinity of said anode and comprising an ionizable medium capable of supporting an arc discharge, means for supplying to said control member a periodic voltage to establish cathode spots on said cathode, and means for controlling the time during the cycles of anode-cathode voltage at which said electric valve means is rendered conducting and comprising a resistance and a rectifier connected across said resistance for increasing the flow of positive current to said control electrode.

8. 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, a control member of the immersion-igniter type associated with said cathode, a control electrode within the vicinity of said anode and employing an ionizable medium capable of supporting an arc discharge, means for transmitting to said control member periodic impulses of current of peaked wave form to ionize said medium, and means for energizing said control electrode to control the time during the half cycles of voltage of said alternating current circuit at which current flow is initiated between said anode and said cathode and comprising means for producing a periodic voltage and means connected between said last mentioned means and said control electrode and comprising in parallel relation a unidirectional conducting device and a resistance.

9. 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, ignition means, a control electrode within the vicinity of said anode and employing an ionizable medium capable of supporting an arc discharge, means for energizing said ignition means and for ionizing said medium only during half cycles of positive voltage of its associated anode, and means for energizing said control electrode to control the time during the half cycles of voltage of said alternating current circuit at which current flow is initiated between said anode and said cathode and comprising means for producing a periodic voltage and means connected between said last mentioned means and said control electrode and comprising in parallel relation a rectifier and a resistance.

10. 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, ignition means associated with said cathode, a control electrode, said electric valve means employing an ionizable medium capable of supporting an arc discharge, means for transmitting to said ignition means periodic impulses of current of peaked wave form to ionize said medium, and means for energizing said control electrode to control the time during the half cycles of voltage of said alternating current circuit at which current flow is initiated between said anode and said cathode and including a transformer and means connected between said transformer and said control electrode for transmitting positive impulses of current thereto and comprising in parallel relation a unidirectional conducting device and a resistance.

11. In combination, an alternating current circuit, a load circuit, electric translating apparatus connected between said circuit and comprising electric valve means including an anode, a cathode and a control member of the immersion-igniter type associated with said cathode, and an excitation circuit for energizing said control member comprising a source of alternating current, transforming means energized from said source and including a winding section having a pair of electrically displaced connections and a connection electrically intermediate said pair of connections, said intermediate connection being connected to said cathode, means connected between one of said pair of connections and said control member and comprising a rectifier of the dry type for transmitting unidirectional current to said control member and means connected between a point intermediate said control member and said rectifier and the other connection of said pair for maintaining said control member substantially at the potential of said intermediate connection durinp the inverse half cycles of voltage of said source.

12. 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, a control member of the immersion-igniter type associated with said cathode and a control electrode, said electric valve means employing an ionizable medium capable of supporting an arc discharge, means for energizing said control member to establish arc discharges within said electric valve means and comprising peaking means for transmitting said control member impulses of current of peaked wave form, and means for impressing on said control electrode a voltage of peaked wave form and variable in phase displacement relative to the voltage of said control member to determine the time during the cycles of voltage of said alternating current circuit at which the flow of current between said anode and said cathode is initiated.

13. 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, a control member of the immersion-igniter type associated with said cathode, a relieving anode and a control electrode within the vicinity of said anode, said electric valve means employing an ionizable medium capable of supporting an arc discharge, excitation means for energizing said control member and comprising means for producing periodic impulses of voltage of peaked wave form to initiate arc discharges within said electric valve means, means for connecting said relieving anode to the last mentioned means, and means for impressing on said control electrode impulses of voltage of peaked wave form in order to control the times during the cycles of voltage of said alternating current circuit at which current flow is initiated between said anode and said cathode.

14. 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, a control member of the immersion-igniter type associated with said cathode, a relieving anode and a control electrode within the vicinity of said anode, means for impressing on said control electrode a biasing potential tending to prevent the transfer of current between said anode and said cathode, excitation means for supplying to said control member periodic impulses of current of peaked wave form to establish arc discharges within said electric valve means, means for connecting the last mentioned means to said relieving anode, and means for impressing on said control electrode periodic voltages of peaked wave form sufficient in magnitude to overcome the effect of said biasing potential to control thereby the times during the cycles of voltage of said alternating current circuit at which current flow is initiated between said anode and said cathode.

15. In combination, an alternating current circuit, a load circuit, electric translating apparatus connected between said circuits and comprising electric valve means capable of supporting an arc discharge and including an anode, a cathode, immersion igniter means associated with said cathode for ionizing said medium and a control electrode, means for energizing said igniter means, means for impressing a biasing potential on said control electrode tending to maintain said electric valve means nonconducting, and means for impressing on said control electrode a periodic voltage of peaked wave form variable in phase displacement relative to the voltage of said immersion igniter means and sufficient in magnitude to overcome the effect of said biasing potential for rendering said electric valve means conducting.

AUGUST SCHMIDT, JR.

CERTIFICATE OF CORRECTION.

Patent No. 2,366,561. January 2, 1945.

AUGUST SCHMIDT, JR.

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 12, for "postive" read --positive--; page 4, second column, line 46, claim 12, after "transmitting" insert --to--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 10th day of April, A. D. 1945.

Leslie Frazer

(Seal)

Acting Commissioner of Patents.

14. 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, a control member of the immersion-igniter type associated with said cathode, a relieving anode and a control electrode within the vicinity of said anode, means for impressing on said control electrode a biasing potential tending to prevent the transfer of current between said anode and said cathode, excitation means for supplying to said control member periodic impulses of current of peaked wave form to establish arc discharges within said electric valve means, means for connecting the last mentioned means to said relieving anode, and means for impressing on said control electrode periodic voltages of peaked wave form sufficient in magnitude to overcome the effect of said biasing potential to control thereby the times during the cycles of voltage of said alternating current circuit at which current flow is initiated between said anode and said cathode.

15. In combination, an alternating current circuit, a load circuit, electric translating apparatus connected between said circuits and comprising electric valve means capable of supporting an arc discharge and including an anode, a cathode, immersion igniter means associated with said cathode for ionizing said medium and a control electrode, means for energizing said igniter means, means for impressing a biasing potential on said control electrode tending to maintain said electric valve means nonconducting, and means for impressing on said control electrode a periodic voltage of peaked wave form variable in phase displacement relative to the voltage of said immersion igniter means and sufficient in magnitude to overcome the effect of said biasing potential for rendering said electric valve means conducting.

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