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TIMER

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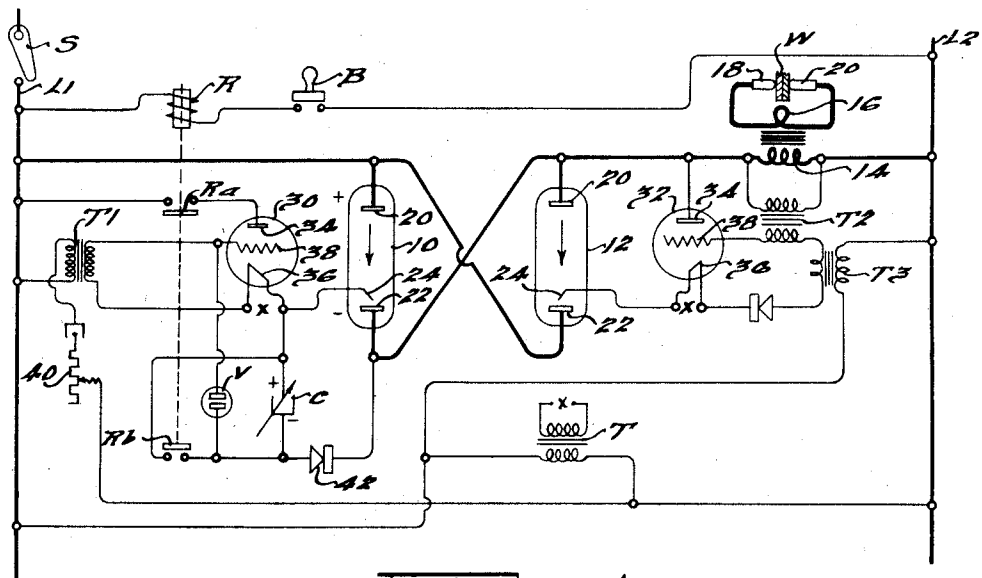


FIG. 1.

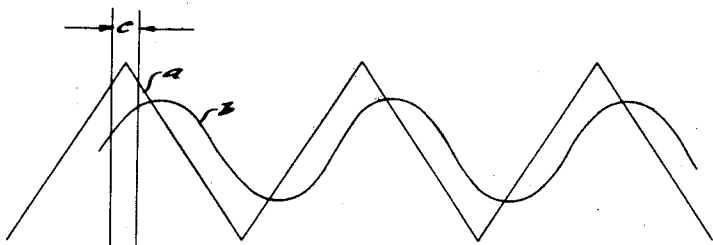


FIG. 2.

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## UNITED STATES PATENT OFFICE

2,295,635

## TIMER

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5 Claims. (Cl. 250—27)

The present invention relates to electrical timing systems and in particular is directed to the provision of an improved timing system for effecting various control functions in synchronous relation to the flow of current in an alternating current system.

The principal objects of the present invention are to provide a timing system of the above generally indicated character, which is reliable in operation, simple in arrangement, and which uses fewer control elements than have heretofore been found necessary to provide equivalent operation; to provide such a system employing an electronic main valve of the type which upon being ignited is effective to pass current in one direction throughout the balance of one-half cycle of current flow, and further employing an electronic control valve for igniting the main valve, the arrangement being particularly characterized in that the control valve is directly employed to control the time of ignition of the main valve; to provide such a system employing additional means associated with the control valve so that upon closure of a starting switch or equivalent, the control valve will effect a predetermined but adjustable number of successive ignitions of the main valve; and to provide a system of the above generally indicated character embodying a second main valve reversely connected to the first main valve and having means associated therewith to ignite it after and as a consequence of the ignition of the first main valve.

With the above, as well as other and more detailed objects in view, which appear in the following description and in the appended claims, a preferred but illustrative embodiment of the invention is shown in the accompanying drawing, in which:

Figure 1 is a diagrammatic representation of circuits embodying the invention; and

Fig. 2 is a diagrammatic representation of voltage relations in the work circuit and in certain of the control circuits.

It will be appreciated from a complete understanding of the present invention that the improvements thereof are applicable to systems intended for widely differing purposes, and may be embodied in widely differing forms. By way of illustration, but not of limitation, the invention is herein specifically disclosed in connection with the control of an alternating current electric welding circuit.

Referring particularly to Fig. 1, the system comprises generally a pair of electronic valves 10 and 12, which may be of usual construction,

and which are reversely connected together in the circuit of the primary winding 14 of a transformer, the secondary winding 16 whereof is illustrated as arranged to supply current to an illustrative welding circuit having usual electrodes 18 and 20, between which the work W is clamped.

The valves 10 and 12 will each be recognized as being provided with an anode 20, a cathode 22, and a control electrode or igniter 24. It will be understood that if an igniter voltage is impressed between the cathode 22 and igniter 24 of the valve 10, for example, at a time when the anode 20 is positive with respect to the cathode 22, the valve 10 will pass current in the direction indicated by the arrow throughout the balance of the corresponding one-half cycle of the current wave, even though the voltage impressed across the terminals of the valve 10 may reverse during such current flow. At the conclusion of such one-half cycle of current flow, also, the valve 10 will become non-conducting until the igniter voltage is again applied thereto at a time while the anode 20 is positive with respect to the cathode 22. The valve 12, of course, has similar operating characteristics.

The ignition of the valve 10 is controlled by a timing circuit comprising the control valve 30 and associated elements, and the ignition of valve 12 is controlled by the control valve 32. The control valves 30 and 32 are each of the usual three-element type, comprising a plate 34, filament 35, and control grid 38. The filaments 35 are arranged to be continuously supplied with current as long as the line conductors L1 and L2 are energized. An illustrative source of filament current for the valves 30 and 32 is represented by the transformer T. It will be understood that the valve 30, for example, will pass current so long as the plate 34 thereof is positive with respect to the filament 35 and so long as the potential of the grid 38 with respect to the filament is maintained at or above a predetermined value, but will become non-conductive if the potential of the grid 38 is reduced below the just-mentioned value.

The potential of the grid 38, associated with the valve 30, is controlled by a transformer T1 and by a timing condenser C. The transformer T1 is of the so-called peaking type, arranged to provide a secondary voltage wave form of the characteristic form indicated at a in Fig. 2. The primary circuit of the transformer T1 is provided with phase shifting elements comprising the capacitive and inductive components 40, so proportioned that the voltage wave in the secondary winding bears the time phase relation to the volt-

age wave *b* of the supply circuit, which is indicated in Fig. 2. As described below, transformer T1 serves to control the time of ignition of the valve 10 and the condenser C serves to determine the number of half cycles during which the transformer T1 is effective. The grid 38 of the control valve 32 is controlled by a transformer T2 which, as described below, is energized in such relation as to render the valve 32 conducting, as a consequence of a previous ignition of the valve 10.

Considering the operation as a whole, it will be appreciated that closure of the line switch S connects the line conductors L1 and L2 to a suitable source of alternating current. This action immediately energizes the transformer T, which thereupon supplies heating current to the filaments 36 of the valves 30 and 32 and also supplies current to the primary winding of the control transformers T1 and T3. Transformer T3 is connected to apply a blocking bias to the grid of valve 32, as is conventional. The secondary winding of transformer T1 is connected in the grid circuit of the valve 30, and it will be appreciated, therefore, that at successive intervals 360 electrical degrees apart, the transformer T1 applies a proper potential to the grid 38 of the valve 30 to render the latter conducting. The connections for transformer T1 are such that the just-mentioned potential is applied to the grid 38 during those half cycles hereafter referred to for convenience as the positive half cycles in which the plate 34 of valve 30 is positive with respect to the filament 36. As previously mentioned, the time phase relation between the instant at which the grid 38 is given a conducting potential and the voltage between the line conductors L1 and L2 is controlled by the phase shifting elements 40 associated with the transformer T1.

Assuming now that it is desired to place the system in operation, and supply current to the indicated welding circuit, the button B may be closed, it being understood that the button B is representative of any suitable manual or automatic starting device. Closure of the button B completes the circuit for the winding of the control relay R, which thereupon closes its contacts Ra and opens its contacts Rb. The latter action is without immediate effect, but closure of contacts Ra connects the plate 34 of the valve 30 to the line conductor L1. If the closure of button B and contacts Ra occurs at any time in a negative half cycle, during which the plate 34 of valve 30 is negative with respect to the filament thereof, such action, of course, does not initiate a flow of plate current through the valve 30. Also, unless the closure of button B and contacts Ra occurs at that critical stage of the positive half wave at which the voltage of transformer T1 is at or near its maximum value, the grid 38 will not be at a proper potential to render the valve 30 conducting. Assuming, however, that the closure of button B and contacts Ra occurs in the interval designated *c* in Fig. 2, valve 30 will immediately be rendered conducting and will impress an igniting voltage between the cathode 22 and the igniter 24 of the valve 10, which action, as aforementioned, will immediately render the latter conducting. Upon being rendered conducting, valve 10 acts as a short circuit for the valve 30 and becomes effective to supply current to the primary winding 14 of the welding transformer through an obvious circuit extending from the line L1 through the contacts Ra, the valve 10, and through the winding 14 to the line L2. The

potential between the cathode 22 and the igniter 24 thereof, which potential obtains during the positive half of the voltage wave, causes charging current to flow to the condenser C, which condenser is directly connected between the elements 22 and 24 in series with a usual rectifier 42.

The flow of welding current through the valve 10 also energizes the primary winding of the control transformer T2, the connections for which are such, however, that during the positive half voltage wave, during which valve 10 can be rendered conducting, transformers T2 and T3 apply a blocking potential to the grid 38 of valve 32. At the conclusion of the positive half cycle, however, the delay in energy in the welding transformer causes a voltage in the transformer T2, which overcomes the bias of transformer T3 and brings the grid 38 of valve 32 to a value at which the valve 32 is rendered conducting. As soon as this action occurs, valve 30 becomes conductive and applies an igniting potential to the valve 12, which action, as in the case of valve 10, renders the valve 12 effective to pass welding current in the direction indicated by the arrow.

At the conclusion of the just-mentioned negative half wave of current flow, the valve 12 again becomes non-conductive and, at the beginning of the succeeding positive half wave of current flow, valve 10 is again rendered conductive in the manner described above. Moreover, at the conclusion of the second positive half wave, valve 12 is again rendered conductive. So long, therefore, as valve 10 is rendered conductive during a positive half cycle, valve 12 is rendered conductive during the succeeding negative half cycle.

It will be noticed that the condenser C is connected in series with a suitable rectifier 42 directly across the cathode 22 and the igniter 24 of the valve 10. During each half cycle of current flow, therefore, during which the valve 10 is conductive, an increment of current is supplied to the condenser C, the rectifier 42 being operative to prevent a dissipation of such charge during the intervening half cycles during which valve 10 is non-conductive.

Condenser C is illustrated as being variable in value, and it will be understood that the value of this condenser may be adjusted so as to require a widely variable number of current impulses in order to bring the charge thereon to the critical value. As soon as condenser C receives sufficient impulses of current to bring the charge thereon to the critical value, it is effective to cause a flow of current through the usual glow discharge valve V and at this time condenser C is operative to apply a negative potential to the grid 38 of the valve 30 and prevent the transformer T1 from rendering the grid 38 sufficiently positive to render the valve 30 conductive. Accordingly, during the next positive half cycle during which valve 30 would normally be rendered conductive, the latter is blocked and no current passes through the valve 10 during the corresponding positive half cycle. The failure of current flow through the valve 10 during the positive half cycle prevents the valve 12 from being rendered conductive and consequently the operation of the system is interrupted at the conclusion of that negative half cycle which preceded the functioning of the condenser C.

The condenser C remains operative to maintain a negative bias on the grid 38 of valve 30 until the former is discharged, and in the present arrangement, the discharge of condenser C is

effected by release of the starting button B, which thereupon de-energizes the relay R, causing closure of the contacts Rb. The contacts Rb complete an obvious discharge circuit for the condenser C, thus conditioning the system for a new operating cycle in response to a closure of the button B.

It will be noticed, in conclusion, that independently of the time of closure of the button B, a current flow through the system and to the welding transformer is initiated only at an early stage of a positive half cycle, and that each such operating cycle is terminated at the conclusion of a negative half cycle. It will further be noticed that the system automatically provides an overall timing feature whereby each closure of the button B will cause a current flow of a definite number of full cycles and will automatically interrupt the flow of current at the conclusion of such interval. The system, moreover, prevents a restarting of the system unless the starting control device is released and then reclosed.

Though only a single embodiment of the invention has been described, it will be appreciated that various modifications in the form, number and arrangement of the parts may be made without departing from the spirit and scope of the invention.

What is claimed is:

1. In a timing system having a source of alternating current, the combination of a first valve having principal electrodes connected to said source and having a control electrode, a second valve having a control electrode and having principal electrodes electrically coupled to said first control electrode and one of said first principal electrodes and effective when rendered conductive to apply a starting potential between said first control electrode and said one principal electrode and thereby render said first valve conductive, means for successively applying a potential in predetermined time phase relation to said source to said second control electrode to successively render the second valve conductive, means including an energy storage device charged by flow of current between said principal electrodes of said second valve, and means coupling said last mentioned means to said second control electrode so as to apply the charged potential of said device to said second control electrode.

2. In a timing source having a source of alternating current, the combination of a first valve having principal electrodes connected to said source and having a control electrode, a second valve having a control electrode and having principal electrodes electrically coupled to said first control electrode and one of said first principal electrodes and effective when rendered conductive to apply a starting potential between said first control electrode and said one principal electrode and thereby render said first valve conductive, means for successively applying a potential in predetermined time phase relation to said source to said second control electrode to successively render the second valve conductive, means including an energy storage device charged by flow of current between said principal electrodes of said second valve and which thereby receives an impulse of charging current each time said first valve is rendered conductive, and means operated in accordance with the integrated value of the charge on said energy storage device for applying the charged potential of said device to said second control electrode.

3. In a timing system having a source of alternating current, the combination of a first valve having principal electrodes connected to said source and having a control electrode, a second valve having a control electrode and having principal electrodes electrically coupled to said first control electrode and one of said first principal electrodes and effective when rendered conductive to apply a starting potential between said first control electrode and said one principal electrode and thereby render said first valve conductive, means for successively applying a potential in predetermined time phase relation to said source to said second control electrode to successively render the second valve conductive, an energy storage device operatively associated with said system so as to receive an impulse of charging current each time said second valve is rendered conductive, and means for applying the charged potential of said device to said second control electrode.

4. In a timing system having a source of alternating current, the combination of a first valve having principal electrodes connected to said source and having a control electrode, a second valve having a control electrode and having principal electrodes electrically coupled to said first control electrode and one of said first principal electrodes and effective when rendered conductive to apply a starting potential between said first control electrode and said one principal electrode and thereby render said first valve conductive, means for successively applying a potential in predetermined time phase relation to said source to said second control electrode to successively render the second valve conductive, an energy storage device operatively associated with said system so as to receive an impulse of charging current each time said second valve is rendered conductive, and means including an additional valve rendered conducting when the charged potential of said device reaches a predetermined value for applying the charged potential of said device to said second control electrode.

5. In a timing system having a source of alternating current, the combination of a first valve having principal electrodes connected to said source and having a control electrode, a second valve having a control electrode and having principal electrodes electrically coupled to said first control electrode and one of said first principal electrodes and effective when rendered conductive to apply a starting potential between said first control electrode and said one principal electrode and thereby render said first valve conductive, means for successively applying a potential in predetermined time phase relation to said source to said second control electrode to successively render the second valve conductive, an energy storage device operatively associated with said system so as to receive an impulse of charging current each time said second valve is rendered conductive, means including a second valve rendered conducting when the charged potential of said device reaches a predetermined value for applying the charged potential of said device to said second control electrode and thereby rendering said second valve ineffective, and second means operable to discharge said device and again render said control valve effective.

CLETUS J. COLLOM.

CERTIFICATE OF CORRECTION.

Patent No. 2,295,635.

September 15, 1942.

CLETUS J. COLLOM.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, second column, line 70, claim 5, for "and second" read "--and control--"; line 71, same claim, for "control" read "--second--"; 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 3rd day of November, A. D. 1942.

(Seal)

Henry Van Arsdale,  
Acting Commissioner of Patents.

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