

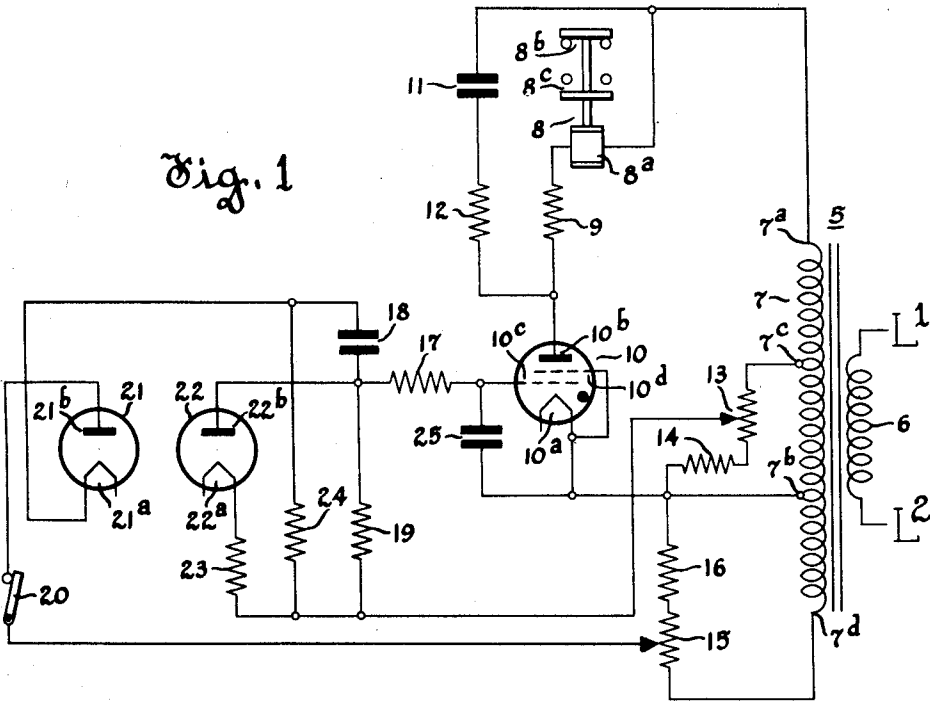
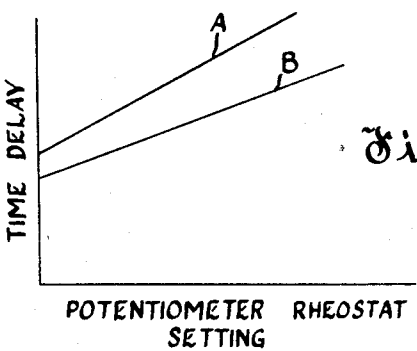
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ELECTRONIC TIMING SYSTEM

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ELECTRONIC TIMING SYSTEM

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5 Claims. (Cl. 317-142)

This invention relates to an electronic timing system of the capacitor type.

This is a continuation of my application, Serial No. 340,639, now abandoned.

A primary object of the present invention is to provide an improved timing system of the aforementioned type which is characterized by having relatively good linearity with respect to time adjustment and fast reset.

Another object is to provide a timing system of the aforementioned type which is further characterized by being relatively insensitive to line voltage fluctuations.

To achieve these objects I provide for charging of a timing capacitor during non-conducting half-cycles of the control tube, through a relatively low resistance charging circuit which excludes a grid-cathode circuit of the tube, firing of the control tube by an adjustable in-phase alternating potential superimposed on the exponential discharge curve of the capacitor and supply of an adjustable capacitor charging potential and said adjustable in-phase firing potential from a common alternating potential source.

Other objects and advantages of the invention will hereinafter appear.

The accompanying drawing illustrates a preferred embodiment of the invention which will now be described; it being understood that the embodiment illustrated is susceptible of various modifications without departing from the scope of the appended claims.

In the drawing:

Figure 1 is a diagrammatic showing of a timing system incorporating the invention, and

Fig. 2 is a graph depicting the variation in time delay afforded by adjustment of certain elements of the system.

In Fig. 1 of the drawing numeral 5 indicates a transformer having a primary winding 6 for connection to a source of alternating current power supply and a secondary winding 7 provided with end and intermediate terminals. An electromagnetic relay 8 having an operating winding 8a, normally closed contacts 8b, and normally open contacts 8c, has one end of its operating winding connected to the upper end terminal 7a of winding 7 and the other end of its aforementioned winding connected in series with a resistor 9 to the anode 10b of a gas filled tube 10, which preferably is of the so-called thyratron type. Tube 10 is provided with cathode 10a, which is connected to the intermediate terminal 7b of winding 7, a control grid 10c and a screen grid 10d. A capacitor 11 and a resistor 12 are connected together in series across the series combination of operating winding 8a and resistor 9. As is well known, winding 8a is energized for closure of contacts 8c and opening of contacts 8b whenever tube 10 is rendered conductive. Tube 10 will, of course, only be conductive when the alternating potential on its anode 10b is positive with respect to the potential on its cathode, which

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occurs during alternate half-cycles of A.-C. potential between terminals 7a and 7b. The portion of the circuit comprising capacitor 11 and resistor 12 acts to maintain winding 8a energized during the non-conducting half-cycles of tube 10 in a well known manner.

The resistance element of a potentiometer 13 is connected at one end to intermediate terminal 7c of winding 7 and at its other end in series with a resistor 14 to the aforementioned terminal 7b. Similarly, the resistance element of a potentiometer 15 is connected at one end to lower end terminal 7d of winding 7, and at its other end in series with a resistor 16 to the aforementioned terminal 7b. Control grid 10c of tube 10 is connected in series with a resistor 17 to the point common between a capacitor 18 and a resistor 19. Resistor 19 is connected at its other end to the adjusting element of potentiometer 13. The adjusting element of potentiometer 15 is connected in series with a pilot switch 20 and the conducting path of a diode 21 to capacitor 18. The common point between resistor 17, capacitor 18 and resistor 19 is connected through the conducting path of a diode 22 and a resistor 23 to the adjusting element of potentiometer 13. A resistor 24 is connected at one end to the point common between the cathode 21a of diode 21 and capacitor 18 and at its other end to the point common between resistors 23 and 19 and the adjusting element of potentiometer 13. A filter capacitor 25 is connected between control grid 10c and cathode 10a of tube 10, and screen grid 10d is connected to the cathode 10a.

In one preferred embodiment constructed in accordance with the invention the aforementioned resistors, potentiometers and capacitors were selected to have the following values:

9	-----ohms---	1.5K
11	-----mfd---	2
12	-----ohms---	100
13	-----do---	1K
14	-----do---	1.2K
15	-----do---	5K
16	-----do---	1.2K
17	-----do---	100K
18	-----mfd---	1
19	-----megohms---	8.2
23	-----ohms---	5.6K
24	-----do---	15K
25	-----mfd---	006

Upon closure of switch 20 capacitor 18 becomes charged through the diode 21 to the peak of the potential drop across resistor 24, which potential drop is approximately the potential difference between the adjusting element of potentiometer 13 and the adjusting element of potentiometer 15. The charging path for capacitor 18 is from the adjusting element of potentiometer 15, through diode 21, through capacitor 18, diode 22, resistor 23, and the adjusting element of potentiometer 13. In order to insure that charging of capacitor 18 is confined through diode 22 and resistor 23 the ohmic value of resistor 23 is made considerably less than the ohmic value of resistors 17 and 19 (on the order of ohms as compared to megohms). This insures that the time constant of the charging circuit is relatively short and makes for rapid reset. Whenever capacitor 18 is charged to the aforementioned potential, tube 10 is rendered non-conducting, although control grid 10c is continually subjected to an alternating potential which is in-phase with the conducting periods of tube 10 and which has a peak value sufficient to render tube 10 conducting if control grid 10c were not also subjected to the

high negative potential of the low potential plate of capacitor 18.

Now if switch 20 is opened, disrupting the charging circuit for capacitor 18, the latter then commences to discharge through the circuit comprising resistors 24 and 19. During discharge of capacitor 18 the potential of which grid 10c of tube 10 is subjected by capacitor 18 increases in accordance with an exponential curve. Within one or two time constants the potential of the low potential plate of capacitor 18 has risen sufficiently so that the superimposed alternating potential will rise sharply above the critical voltage of tube 10 and render the same conducting. As aforeindicated, conduction of tube 10 energizes the operating winding 8a of relay 8 and such winding will thereafter remain energized so long as switch 20 is maintained in open position.

Reclosing of switch 20 again establishes the charging circuit for capacitor 18 and as soon as the latter becomes sufficiently charged tube 10 will thereafter be blocked from further conduction during its conducting half-cycles, and accordingly winding 8a of relay 8 will thereafter be deenergized with its contacts returning to the respective positions shown in the drawing.

Referring to Fig. 2, curve A depicts the variation in time delay obtainable between opening of switch 20 and energization of relay 8 for different settings of the adjusting element of potentiometer 15 when the adjusting element of potentiometer 13 is in its top extreme position on its associated resistance element. Curve B illustrates the variation in time delay obtainable for different positions of the adjustment element of potentiometer 15 with the adjusting element of potentiometer 13 in its lowermost position on the resistance element thereof. Change in the position of adjusting element of potentiometer 15 changes the potential to which capacitor 18 is charged and affords the basic timing adjustment for the system. Change in the adjustment of the adjusting element of the potentiometer 13 changes the amplitude of the in-phase alternating potential to which control grid 10c of tube 10 is subjected. The change in time for a given change in adjustment of potentiometer 13 is not nearly as great as for a corresponding change in adjustment of potentiometer 15, and might be likened to a "vernier" adjustment. As shown by curves A and B of Fig. 2 its practical effect is to shift the total range of adjustment. It will be understood further that the resistances of resistors 14 and 16, respectively, may be so chosen as to yield curves similar to A and B, but displaced therefrom.

It has been found that the aforedescribed timing system is relatively insensitive to line voltage fluctuations, that is to say for a given change in voltage to which primary winding 6 is subjected from rated line voltage, the variation in time delay between opening of switch 20 and energization of the winding 8a of relay 8 will be negligible. For example, assume that the voltage impressed on winding 6 is depressed a given amount below rated line voltage, then there will be a proportionate change in voltages at the various terminals of the secondary winding 7. Thus, although capacitor 18 will be charged to a lesser potential due to such line voltage depression there will be a corresponding reduction in the peak value of the superimposed A.-C. potential on grid 10c of tube 10. These changes tend to offset one another thereby minimizing the amount of change in the time delay that might otherwise occur because of line voltage fluctuation.

It will be noted that in the aforedescribed system charging of the capacitor 18 is not effected through the grid-cathode circuit of the tube 10, which makes for greater constancy in the critical grid voltage of this tube and improves the accuracy of the timer. The coordination of elements in this system, further, is such that by proper choice of constants linear time delay characteristics such as indicated in curves A and B of Fig. 2 are obtainable.

The gaseous tube 10 shown may be replaced by a suitable high vacuum tube and the screen grid 10d omitted in either case without departure from the essence of the present invention.

I claim:

1. In combination, a source of alternating potential, an electron tube having an auxiliary electrode for control, translating means connected in series with the main conducting path of said tube to said source, means in circuit with said source and said auxiliary electrode for subjecting the latter to an alternating potential tending to render said tube conducting, a capacitor in circuit with said auxiliary electrode, means in circuit with said source and said capacitor providing an interruptible charging circuit for the latter to subject said auxiliary electrode to a potential blocking conduction of said tube when said charging circuit is completed, means in circuit with said capacitor which acts as a time delay discharge circuit whenever said charging circuit is interrupted, and means isolating flow of charging current from said tube and confining discharge of said capacitor to said discharge circuit.

2. In combination, a source of alternating potential, an electron tube having an auxiliary electrode for control, translating means connected in series with the main conducting path of said tube to said source, a first adjustable means in circuit with said source and said auxiliary electrode for subjecting the latter to an adjustable alternating potential in-phase with the anode potential of said tube and tending to render the latter conducting, a capacitor in circuit with said auxiliary electrode, a second adjustable means in circuit with said source and affording an adjustable potential which is out-of-phase with the anode potential of said tube, means in circuit with said capacitor affording it a time delay discharge circuit, and means in circuit with said second adjustable means and said capacitor providing a charging circuit for the latter to subject said auxiliary electrode to a potential blocking conduction of said tube when said charging circuit is completed and including a switch for selectively completing and interrupting said charging circuit, and means, including unidirectional conducting means in said charging circuit, isolating flow of charging current from said tube and confining discharge of said capacitor to said discharge circuit.

3. The combination with a source of alternating current supply, an electron tube having an auxiliary electrode for control and an electromagnetic relay having its control winding connected in series with the main conducting path of said tube to said source, of a first potentiometer in circuit with said source and said auxiliary electrode for subjecting the latter to an adjustable alternating potential in-phase with the anode potential of said tube tending to render the latter conducting, a capacitor in circuit with said auxiliary electrode, a second potentiometer in circuit with said source and affording an adjustable alternating potential out-of-phase with the anode potential of said tube, a discharge circuit for said capacitor, means including a switch in circuit with said second potentiometer and said capacitor providing an interruptible charging circuit for the latter to subject said auxiliary electrode to a potential blocking conduction of said tube when said charging circuit is completed, and means, including unidirectional conducting means in said charging circuit, isolating flow of charging current from said tube and confining discharge of said capacitor to said discharge circuit.

4. The combination with a source of alternating current supply, an electron tube having an auxiliary electrode for control and an electromagnetic relay having its control winding connected in series with the main conducting path of said tube to said source, of a first potentiometer in circuit with said source and said auxiliary electrode for subjecting the latter to an adjustable alternating potential in-phase with anode potential of said tube tending to

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render the latter conducting, a capacitor in circuit with said auxiliary electrode, a second potentiometer in circuit with said source and affording an adjustable alternating potential out-of-phase with the anode potential of said tube, a discharge circuit for said capacitor, means including a switch in circuit with said second potentiometer and said capacitor providing an interruptible charging circuit for the latter to subject said auxiliary electrode to a potential blocking conduction of said tube when said charging circuit is completed, and means, including half wave rectifiers on each side of said capacitor in said charging circuit, to isolate flow of charging current from said tube and to confine discharge of said capacitor to said discharge circuit.

5. In a time delay system, the combination with an electron tube having an auxiliary electrode for controlling conduction thereof, a source of alternating potential and an electromagnetic relay having its operating winding connected in series with the main conducting path of said tube, of a capacitor in circuit with said auxiliary electrode, a first potentiometer having its resistance element in circuit with said source and its adjusting element in circuit with said auxiliary electrode for subjecting the latter to an adjustable potential in-phase with the anode potential of said tube tending to render the latter conducting, a second potentiometer having its resistance ele-

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ment in circuit with said source and providing an adjustable potential out-of-phase with the anode potential of said tube at its adjusting element, means in circuit with the adjusting elements of said potentiometers and said capacitor affording the latter a low impedance charging circuit and including a switch for completion and interruption thereof, a relatively higher impedance discharge path in circuit with said capacitor, and means, including half wave rectifiers on each side of said capacitor in said charging circuit, isolating flow of charging current from said tube and confining discharge of said capacitor to said discharge circuit.

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