July 8, 1952 M. AUDIER 2,602,888

ELECTRONIC TIMER

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Fig. 1

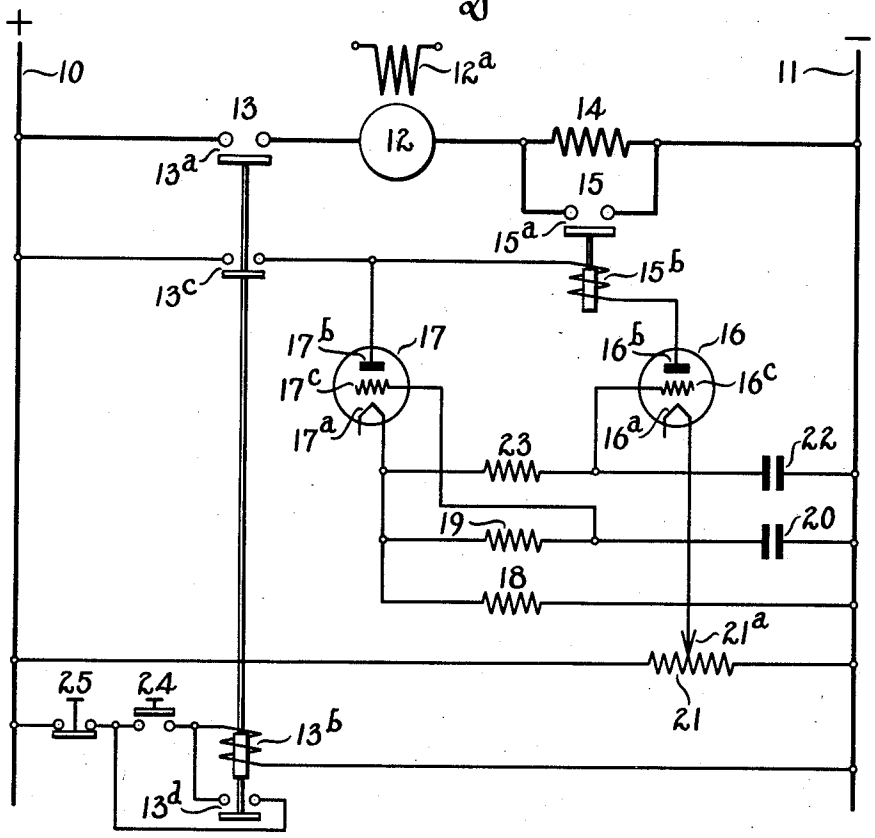
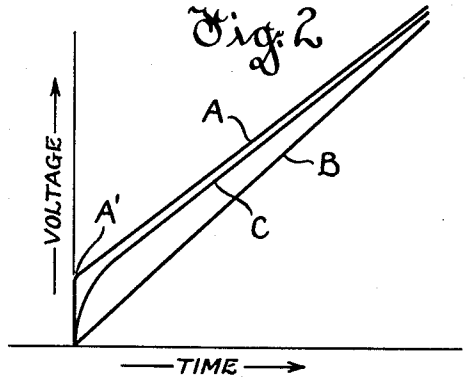


Fig. 2



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ELECTRONIC TIMER

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3 Claims. (Cl. 250—27)

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This invention relates to improvements in electric timing systems of the condenser type.

Condensers have heretofore been employed in timing systems but not to full advantage, the prior uses having been such as to necessitate a relatively large condenser where a substantial time element is needed. The time element obtained has been an exponential function of the change in voltage of the condenser and as a consequence the condenser capacity has not been employed efficiently.

The present invention has among its objects to provide a system wherein the condenser is so utilized that the potential change of which timing is a function is linear and whereby the condenser capacity is more efficiently employed.

Another object is to provide a timing system which is of increased accuracy and which affords with use of a condenser of given capacity a longer timing period.

Another object is to provide a timing system of the condenser type wherein such more advantageous use of the condenser is enabled by a readily accomplished coordination of the condenser and an electron tube.

Another object is to provide a timing system of the character aforeindicated which affords adjustment over a wide range of the time element provided thereby.

Another object is to provide a timing system having numerous advantageous applications including timing of circuit commutations for motors and other translating devices.

Other objects and advantages will hereinafter appear.

The invention comprehends a system in which the potential of a circuit element is varied substantially linearly as a function of lapse of time following initiation of a given condition of the circuit whereby an effect is produced upon the circuit as such potential attains a given value. A more specific example is raising linearly with the lapse of time the potential of the cathode of an electron tube supplied with energy by varying the potential of the control electrode of the tube with respect to the cathode in accordance with the change of the cathode potential.

The accompanying drawing is illustrative of an embodiment of the invention, it being understood that the embodiment illustrated is susceptible of various modifications without departing from the scope of the appended claims.

Fig. 1 is a connection diagram showing the timing system applied to control of an electric motor, and

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Fig. 2 is a curve of the potential of certain elements of the system shown in Fig. 1.

The system as shown in Fig. 1 comprises a positive bus bar 10 and a negative bus bar 11 of a direct current supply which furnishes electrical energy to the armature 12 of a direct current motor whose shunt field winding 12^a may be energized in any suitable manner.

One terminal of the armature 12 is connected to the bus bar 10 through a normally open main contact 13^a of an electromagnetic switch 13 which is provided with an energizing winding 13^b and normally open auxiliary contacts 13^c and 13^d. The other terminal of the armature 12 is connected through a starting resistor 14 to the bus bar 11. The starting resistor 14 may be short circuited by the normally open contact 15^a of an electromagnetic switch 15 which is provided with an energizing winding 15^b. One terminal of the winding 15^b is connected to the anode 16^b of an electron tube 16 which also has a cathode 16^a and a control electrode 16^c. A high vacuum electron tube 17 is provided with a cathode 17^a, an anode 17^b, and a control electrode 17^c. The cathode 17^a is connected through a resistor 18 to the bus bar 11. The anode 17^b is connected to one terminal of the winding 15^b and also to one terminal of contact 13^c. The second terminal of contact 13^c is connected to bus bar 10. A resistor 19 is interposed between the cathode 17^a and the control electrode 17^c, and the control electrode 17^c is also connected through a condenser 20 to the bus bar 11. The cathode 16^a is connected to the movable contact 21^a of a voltage divider 21, which in turn is connected across the bus bars 10 and 11. The control electrode 16^c is connected to the bus bar 11 through a small condenser 22 and to the cathode 17^a through a protective resistor 23. One terminal of the energizing winding 13^b of main switch 13 is connected through a normally open push button switch 24, in series with a normally closed push button switch 25, to the bus bar 10, while the contact 13^d is connected to parallel the push button switch 24. The other terminal of winding 13^b is connected to bus bar 11.

The system operates in the following manner. When the bus bars are energized and the field winding 12^a of the motor is excited, the push button switch 24 may be momentarily closed thereby completing a circuit from bus bar 10 through the contacts of the push button switches 25 and 24 to and through the energizing winding 13^b, to bus bar 11. Thereupon the switch 13 is energized to close the contacts 13^d so that now the push button switch 24 may be released, the winding 13^b re-

maining energized. In responding, the switch 13 also closes the contacts 13a and 13c. Closure of contact 13a connects the motor armature 12 to the bus bars 10 and 11 in series with the resistor 14 and the motor begins to accelerate. Closure of contacts 13c connects the tube 17 across the bus bars 10 and 11 in series with the resistor 18.

Before closure of the contact 13c the potential of the cathode 17a and also of the control electrode 17c was that of the bus bar 11, and as no current flowed through tube 17 the voltage drop in the resistors 18 and 19, and the potential across the condenser 20 were zero. At the instant when the contact 13c closes the tube 17 becomes conducting, which produces a voltage drop across the resistors 18 and 19, resistor 19 producing a biasing potential of the control electrode 17c with respect to the cathode 17a. This biasing potential controls the impedance of the tube 17 and therefore the voltage drop through the resistor 18. The voltage drop across resistor 18 determines the final charging potential applied to the condenser 20, the rate of charge of said condenser and the rate of rise of its potential being limited by the resistor 19. As the charge of the condenser 20 increases, the potential of the control electrode 17c becomes increasingly positive and this in turn increases the current flowing through the resistor 18 and the voltage drop therethrough. The voltage drop across the resistor 18 continues to exceed the voltage drop across condenser 20 by an amount which is equal to that control electrode potential necessary to produce the voltage drop in the resistor 18. This action in turn produces a substantially linear rise of the potential of the condenser 20 and of the voltage drop across the resistor 18 and therefore of the potential of the cathode 17a.

The potential of the cathode 17a is impressed through the resistor 23 upon the control electrode 16c of the tube 16. The potential of the control electrode 16c with respect to the cathode 16a is controlled by adjustment of the contact 21a. The adjustment is such that initially the potential of the control electrode 16c prevents conduction of current by the tube 16. As the potential of the cathode 17a rises, the potential of the control electrode 16c rises correspondingly so that ultimately the tube 16 becomes conducting, thereby energizing the relay winding 15b sufficiently to afford closure of contacts 15a to short circuit the resistor 14, whereupon the motor will further accelerate to full speed.

The accompanying diagram (Fig. 2) illustrates the potential variations just discussed. Before closure of the contacts 13c, the potential of the cathode 17a is that of the negative bus bar 11. When the contacts 13c close, the tube 17 is conducting, as the potential of control electrode 17c is the same as that of the cathode 17a under which conditions the tube is slightly conducting. The tube current passing through the resistor 18 renders the cathode 17a positive, its potential suddenly rising to the value A'. The potential drop through resistor 18 is impressed on the parallel circuit comprising the condenser 20 and resistor 19, the latter controlling the rate of charge of the condenser 20. As a result the voltage of condenser 20 and with it the potential of the control electrode 17c rises linearly in accordance with the curve B. This in turn increases the conductivity of tube 17, thereby raising the potential of the cathode 17a linearly as indicated by curve A. The potential of the cathode 17a is impressed through the resistor 23 and the condenser 22 and the latter is charged exponentially at a very rapid rate. Thereafter its potential rises in accordance with the rise of the rising potential impressed upon it by the resistor 18 as shown by curve C. As the potential of the condenser 22 is impressed on the control electrode 16c, the tube 16 ultimately becomes conducting to energize the switch 15 which short circuits resistor 14. The potential of the cathode 16a with respect to the control electrode 16c may be varied by adjustment of the contact 21a. Thus the absolute potential of the control electrode 16c of the tube 16 affords energization of the switch 15 and therefore the time interval between closure of contacts 13c and response of switch 15 may be varied.

It will be apparent that the linearly varying voltage of the condenser 20, or the linearly varying potential of the cathode 17a may be impressed upon circuits other than that shown to produce commutation of such circuits after the lapse of a given time from the moment of initiation of conduction of the tube 17. Furthermore, the tube 16 may be of other than the gaseous type.

It will also be obvious that the system may be used to control energization of the switch 15 or some other translating device from a circuit in which the voltage is normally insufficient to actuate the device, but increases to a higher value, whereupon the response of the device to said higher value is delayed in the manner aforedescribed.

I claim:

1. A timing circuit comprising, in combination with a constant potential unidirectional source of current, a high vacuum tube having a cathode, an anode and a control electrode, a first resistor connecting said cathode directly to said source, a second resistor connected to said cathode, a condenser connected in series with said second resistor and together therewith in parallel with said first resistor, a connection between the control electrode of said tube and the common terminal of said second resistor and said condenser, a switch to control the connection of said anode to said source, a second electron tube having a cathode, an anode and a control electrode, means to impress the voltage of said source upon the main conducting path of said second tube, a third resistor connected to the cathode of the first mentioned tube, a second condenser connected in series with said third resistor and together therewith in parallel with said first resistor, and a connection between the control electrode of said second tube and the common terminal of said third resistor and said second condenser.

2. A timing circuit comprising, in combination with a constant potential unidirectional source of current, a high vacuum tube having a cathode, an anode and a control electrode, a first resistor connecting said cathode directly to said source a second resistor connected to said cathode, a condenser connected in series with said second resistor and together therewith in parallel with said first resistor, a connection between the control electrode of said tube and the common terminal of said second resistor and said condenser, a switch to control the connection of said anode to said source, a second electron tube having a cathode, an anode and a control electrode, means including a translating device to connect the main conducting path of said second tube to said source and further including means to vary the potential impressed upon the cathode of said tube, a third resistor connected to the cathode of the first mentioned tube, a second condenser con-

nected in series with said third resistor and together in parallel with said first resistor, and a connection between the control electrode of said second tube and the common terminal of said third resistor and said second condenser.

3. A timing circuit comprising, in combination with a constant potential unidirectional source of current, a high vacuum tube having a cathode, an anode and a control electrode, a first resistor connecting said cathode directly to said source, a second resistor connected to said cathode, a condenser connected in series with said second resistor and together therewith in parallel with said first resistor, a connection between the control electrode of said tube and the common terminal of said second resistor and said condenser, a switch to control the connection of said anode to said source, a second electron tube having a cathode, an anode and a control electrode, means including a translating device to connect the main conducting path of said second tube to said source and further including a voltage divider for varying the potential impressed on the cathode

of said second tube, a third resistor connected to the cathode of the first mentioned tube, a second condenser connected in series with said third resistor and together therewith in parallel with said first resistor, and a connection between the control electrode of said second tube and the common terminal of said third resistor and said second condenser.

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