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ELECTRONIC TIMER

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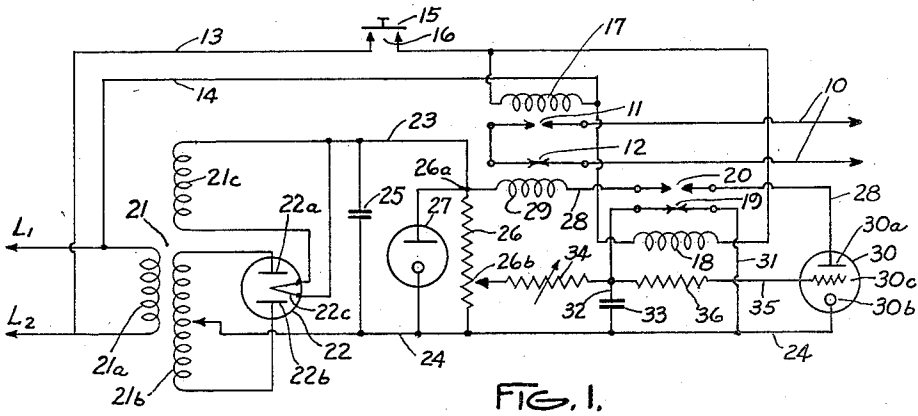


FIG. 1.

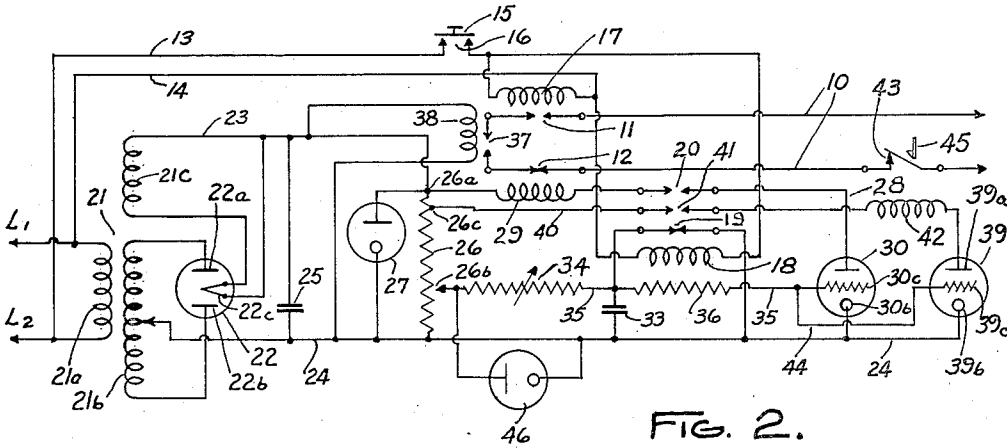


FIG. 2.

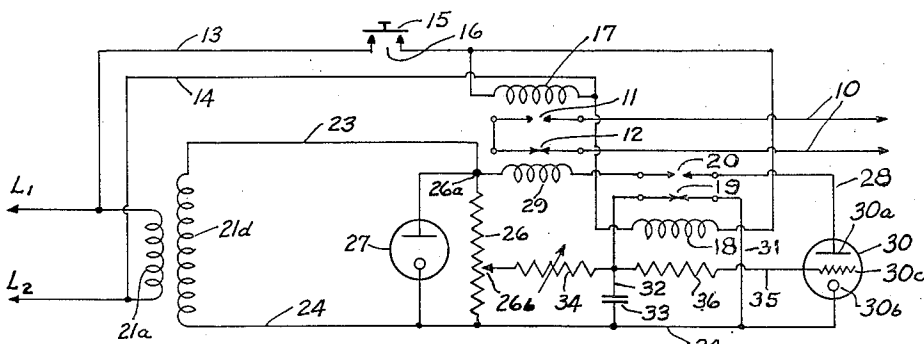


FIG. 3.

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ELECTRONIC TIMER

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5 Claims. (Cl. 315-238)

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This invention relates to improvements in a timer of the electronic type and adapted to cause the closing and opening of a power circuit.

An object of the present invention is to provide novel means for very accurately timing periods of short duration.

Another object of the present invention is to provide a circuit wherein the time period depends upon a space-discharge device to which voltage is applied only for the very short duration of the operation timed.

Another object of the present invention is to provide timing means controlled by the time period necessary to build up a predetermined charge on a condenser which is short circuited except during the short period when a timing operation is being performed.

Another object of the present invention is to provide novel means for insuring that the controlled circuit will be opened at the end of a selected time period or very shortly thereafter under all circumstances.

Other objects of the invention comprise the provision of safety devices insuring the proper operation of all parts at all times and the novel arrangement of circuits as disclosed in the accompanying drawings and specification, and the essential features of my invention will be set forth in the appended claims.

In the drawings,

Fig. 1 is a view showing one embodiment of my invention utilizing rectified A. C. current in the timing circuit;

Fig. 2 is similar to Fig. 1 but illustrates a number of safety features added to the circuit of Fig. 1 to insure the proper operation under all circumstances; while

Fig. 3 is a circuit similar to Fig. 1 but utilizing A. C. current in the timing circuit.

Referring to Fig. 1, the circuit 10 represents the controlled circuit in which the electrical energy is to be applied for a predetermined period. In one form of my device, it is utilized for controlling the exposure of an X-ray tube. Referring to United States Letters Patent Number 2,267,908, granted December 30, 1941, to Edwin R. Goldfield et al., my circuit 10 of the present application might well be used to energize the relay 17 of the said Goldfield et al. patent so as to hold the X-ray tube circuit in energized condition so long as the relay is energized by my controlled circuit, and when my control circuit is de-energized, then the relay 17 would be de-energized and the contact member 16 of the Goldfield et al. patent would automatically open and

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de-energize the X-ray tube circuit. This application of my invention is illustrative only and in no sense a limitation upon my invention.

Referring back to Fig. 1 of the drawings, in series in the circuit 10 is a pair of normally open contacts 11 (which are closed at the beginning of a timed period) and a set of normally closed contacts 12 (which are opened to terminate a timed period). To a suitable low voltage source L₁, L₂, are connected lines 13 and 14. In one of these lines is placed the manually controlled push-button 15 whose associated contacts 16 are normally opened, and closed only so long as the button 15 is held down. Connected between lines 13 and 14 is a relay coil 17 which controls the contacts 11. A second relay coil 18 is connected between lines 13 and 14 for the purpose of controlling two sets of contacts, namely 19 and 20, as will later appear.

The circuit for controlling the timing operation comprises a transformer 21 having a primary 21a energized from the source L₁, L₂, and two secondaries 21b and 21c. A known rectifier circuit is illustrated comprising the rectifier tube 22 whose plates 22a and 22b are connected with opposite ends of the transformer winding 21b and whose cathode 22c is energized from the transformer winding 21c. Rectified current is thus supplied between line 23 and line 24, the latter having a central tap on the transformer winding 21b. The usual condenser 25 is connected between lines 23 and 24. The resistance 26 is connected between lines 23 and 24, and a voltage regulator tube 27 is connected in parallel with this resistance to maintain a constant voltage between the tap 26a and line 24. Thus tube 27 is shown with a cold cathode, but may be provided with a hot cathode if desired. Line 28 is connected with tap 26a and contains in series the relay coil 29 which controls the contacts 12. Also in series in line 28 is the pair of normally open contacts 20 previously mentioned. A triode 30 is connected between lines 28 and 24. The triode has a plate 30a, a cathode 30b and a control grid 30c. This tube is of the "glow" type which is non-conducting until the charge on the grid 30c rises to a certain threshold value. The tube is shown with a cold cathode but might have a hot cathode if desired. One of the pair of normally closed contacts 19 is connected by line 31 to line 24. The other of the contacts 19 is connected by line 32 to line 24 and in this line is provided the condenser 33. The voltage across condenser 33 is supplied from tap 26b on resistance 26 through variable resistance 34.

The charge on grid 30c is provided through line 35 in which is found the resistance 36.

The operation of the device of Fig. 1 is as follows:

An exposure is started when push-button 15 is manually closed to energize the relay 17 which thus closes the normally open contacts 11 and completes the circuit 10. At the time push-button 15 is closed, it energizes the relay coil 18 also. This opens the normally closed contacts 19, which up to this moment have kept the condenser 33 short circuited. A charge then begins to build up on condenser 33 and the charging rate of this condenser is determined by (a) the potential between tap 26b and line 24 (this is adjustable to give a rough time adjustment), (b) by the capacitance of condenser 33, and (c) by the value of the variable resistance 34 which is adjustable to give a finer time adjustment.

At the moment the relay coil 18 opened the contacts 19, it also closed the normally open contacts 20. This placed the substantially constant potential between tap 26a and line 24 across the tube 30. This is a trigger tube as mentioned above and is non-conducting until the charge on the grid 30c rises to a predetermined value. It will be noted that there is no potential across the tube 30 until the moment a timing operation begins.

When the condenser 33 is charged sufficiently to bring the grid 30c to the threshold point necessary to render the tube 30 conducting, current flows in line 28 thus energizing relay coil 29 and opening the normally closed contacts 12 to de-energize the controlled circuit 10.

The contacts 12 will remain open as long as relay 29 is energized which in turn is as long as the tube 30 remains conducting. As is well known, the only way to recycle or to stop the trigger tube 30 from conducting (when D. C. current is used) is to remove the current entirely. In other words, push-button 15 must be opened to set the device for another exposure.

The above-described device is very accurate because tube and condenser leakage in the timing circuit is held to a minimum. No power is applied to tube 30 and the condenser 33 is short circuited until the instant the timed period begins, and all of the factors controlling the charging of the condenser 33 are accurately predetermined.

The apparatus of Fig. 2 includes all of the parts described in connection with Fig. 1 with the addition of certain other parts either to render the apparatus more accurate in its operation or to insure the safe operation thereof under all conditions. All parts which are exactly like those of Fig. 1 and which operate as there described have been given the same reference characters in Fig. 2, and further description of these features will, therefore, be unnecessary.

To insure against voltage failure in the timing circuits, a pair of normally open contacts 37 has been provided in series in the controlled circuit 10. The relay winding 38 is connected between lines 23 and 24 and is so constructed and arranged that when the voltage is normal in the winding 38 it holds the contacts 37 closed, but on partial or entire failure of the voltage in the transformer or rectifier circuit, the contacts 37 will open automatically and energization of circuit 10 under these circumstances is impossible.

A study of Fig. 1 will show that if tube 30 should fail, the energization of circuit 10 would extend past the period set on the timing device,

and in Fig. 2 I have shown means for protecting the apparatus against such faulty operation. To this end, tube 39, similar to tube 30 but having a slightly different grid, is connected in parallel with tube 30 between the upper end of resistance 28 and line 24. The tap 26c for this purpose is close to 26a and is connected by line 40 to the plate 39a of the tube 39. In series in line 40, are the pair of normally open contacts 41 under the control of the relay winding 18. Also in line 40 is the relay winding 42 which controls the normally closed relay contacts 43 which are in the circuit 10. The cathode 39b of tube 39 is connected with line 24. The grid 39c is connected by 44 to line 35. The tube 39 is so constructed and arranged that it becomes conducting when the charge on grid 39c is a small amount, say five or ten volts, higher than the charge on grid 30c necessary to render the tube 30 conducting. It results from this construction, that upon failure of tube 30, the time period will continue until the charge on condenser 33 has risen slightly above the normally intended value so as to build up a charge on grid 39c sufficient to render tube 39 conducting. Thereupon, current flows through line 40, tube 39, and line 24 thus energizing relay winding 42 and opening the normally closed contacts 43. This will de-energize circuit 10 after a time period, but slightly longer than would have been the case had tube 30 been functioning properly.

Preferably, but not necessarily, I make the relay points 43 of the latched-out type which I have indicated diagrammatically by the latch 45. The operation of this type of relay is well known and results in the contacts 43 being latched in open position once they are opened by the energization of the relay winding 42. This will call the attention of the operator to the fact that tube 39 has failed so that a new tube may be inserted in place thereof. The latch 45 must be manually reset before another operation may be performed, and it is assumed that before resetting this latch relay, the operator will insert a new tube 30 so that the device is again safe against operation for an extended time period other than that intended or expected.

A modification of Fig. 2 which may or may not be used is the insertion of the voltage regulator tube 46 between lines 23 and 24. This insures a little more positively a constant voltage at tap 26b and insures a little more accurately that the condenser 33 will be charged in exactly the time interval selected.

Fig. 3 is like Fig. 1 except that it illustrates the use of A. C. current in the timing circuits. To this end, the low voltage source L₁, L₂, is connected to the primary winding 21a as before, but the secondary winding 21d is directly across the lines 23 and 24. The rest of the circuits are like those shown in Fig. 1 and perform the same functions, and, therefore, have been given the same reference characters. One difference in this circuit from that shown in Fig. 1 is that using A. C. current across the tube 30, it might be possible for this tube to recycle and to go on with the energization of circuit 10 if the push-button 15 were held closed. This might or might not be disadvantageous depending upon the circumstances. To avoid this possibility, the rectified current of Fig. 1 may be used.

What I claim is:

1. Means for timing the period of energization of a power circuit comprising means for causing energization of said circuit including a first relay,

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means for causing de-energization of said circuit including a second relay, an energizing timing circuit for said second relay including in series a pair of normally open contacts and a space discharge tube of the trigger type having a control grid controlling the conductivity condition of said tube and a source of substantially constant electric potential for said timing circuit, a condenser circuit including a condenser controlling the potential of said grid and a source of electricity for charging said condenser and a short circuit for said condenser including a pair of normally closed contacts, voltage regulator means for controlling the potential of said electrical sources for said timing circuit and for said condenser circuit, relay means for opening said normally closed contacts of said condenser circuit and for closing said normally open contacts of said timing circuit, means for energizing said relay means substantially simultaneously with energization of said first relay, and said second relay being responsive to a change in the conductivity condition of said tube to cause deenergization of said power circuit.

2. Means for timing the period of energization of a power circuit comprising means for causing energization of said circuit including a first relay, means for causing de-energization of said circuit including a second relay, an energizing timing circuit for said second relay including in series a pair of normally open contacts and a space discharge tube of the trigger type having a control grid controlling the conductivity condition of said tube and a source of substantially constant electric potential for said timing circuit, a condenser circuit including a condenser controlling the potential of said grid and a source of electricity for charging said condenser and a short circuit for said condenser including a pair of normally closed contacts, relay means for opening said normally closed contacts of said condenser circuit and for closing said normally open contacts of said timing circuit, means for energizing said relay means substantially simultaneously with energization of said first relay, said second relay being responsive to a change in the conductivity condition of said tube to cause de-energization of said power circuit, a second space discharge tube of the trigger type connected in parallel with said first named trigger tube, said second trigger tube having a control grid connected in parallel with said first named control grid, said second trigger tube being adapted to change its conductivity condition at a potential of its control grid slightly higher than the threshold potential of the control grid of said first named trigger tube, a safety relay in circuit with said second trigger tube adapted on a change in conductivity condition of said second trigger tube to cause de-energization of said power circuit, and a pair of normally open contacts in series circuit with said second trigger tube and adapted to be closed by energization of said relay means.

3. Means for timing the period of energization of a power circuit comprising means for causing energization of said circuit including a first relay, means for causing de-energization of said circuit including a second relay, and energizing timing circuit for said second relay including in series a pair of normally open contacts and a space discharge tube of the trigger type having a control grid controlling the conductivity condition of said tube and a source of substantially constant electric potential for said timing circuit, a condenser circuit including a condenser controlling the potential of said grid and a source of electricity for

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charging said condenser and a short circuit for said condenser including a pair of normally closed contacts, relay means for opening said normally closed contacts of said condenser circuit and for closing said normally open contacts of said timing circuit, means for energizing said relay means substantially simultaneously with energization of said first relay, said second relay being responsive to a change in the conductivity condition of said tube to cause de-energization of said power circuit, a second space discharge tube of the trigger type connected in parallel with said first named trigger tube, said second trigger tube having a control grid connected in parallel with said first named control grid, said second trigger tube being adapted to change its conductivity condition at a potential of its control grid slightly higher than the threshold potential of the control grid of said first named trigger tube, a safety relay in circuit with said second trigger tube adapted on a change in conductivity condition of said second trigger tube to cause de-energization of said power circuit, manually resettable maintaining means for holding said safety relay in power-circuit-de-energizing position, and a pair of normally open contacts in series circuit with said second trigger tube and adapted to be closed by energization of said relay means.

4. Means for timing the period of energization of a power circuit after initial operation thereof including a relay for initiating operation thereof, two space discharge tubes, each of said tubes having a control grid controlling the conductivity condition of its associated tube at a predetermined threshold, a condenser in circuit with said grids in parallel, electrical contact means normally short-circuiting said condenser, and electrical circuit energized by said first named relay for opening said contact means, a source of electricity for charging said condenser, an electrical circuit energized by said first named relay for connecting said source with said condenser, a relay responsive to a change in the conductivity condition of each of said tubes for causing opening of said power circuit, and the threshold of one of said tubes being slightly higher than the threshold of the other of said tubes, whereby said tube of higher threshold is normally unoperated and is available for operation upon failure of said tube of lower threshold.

5. Means for timing the period of energization of a power circuit after initial operation thereof including means for initiating operation thereof, means for causing de-energization of said circuit including a relay, an energizing timing circuit for said relay including in series a pair of normally open contacts and a space discharge tube having a control grid controlling the conductivity condition of said tube and a source of substantially constant electrical potential for said timing circuit, a condenser circuit including a condenser controlling the potential of said grid and a source of electricity for charging said condenser and a short-circuit for said condenser including a pair of normally closed contacts, voltage regulator means for controlling the potential of said electrical sources for said timing circuit and for said condenser circuit, said condenser circuit including a variable tap on its associated electrical source for providing a rough time adjustment, said condenser circuit including other variable means for providing a fine time adjustment, relay means for opening said normally closed contacts of said condenser circuit and for closing said normally open contacts of said timing circuit, means

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for energizing said relay means responsive to said first named means, and said relay being responsive to a change in the conductivity condition of said tube to cause de-energization of said power circuit.

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