

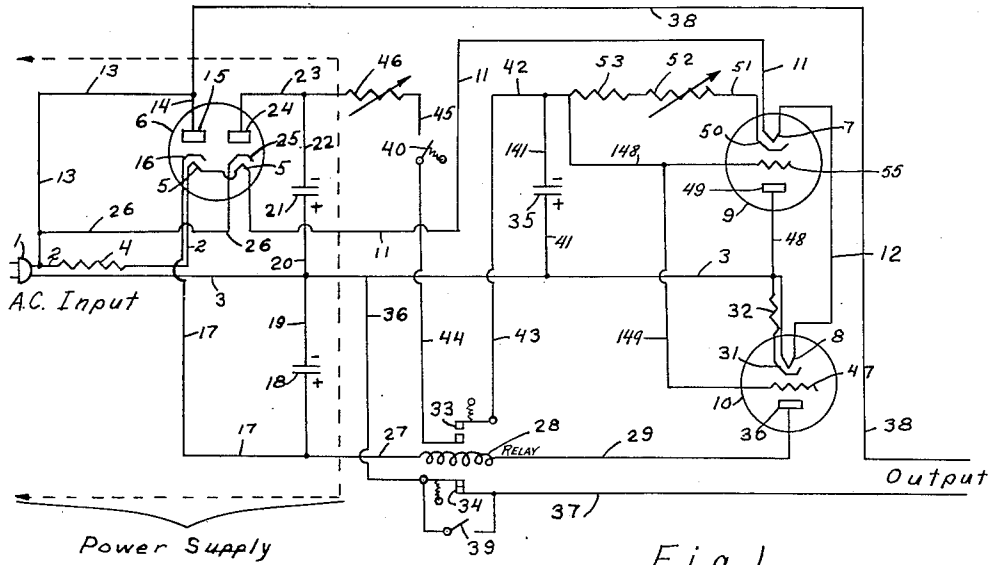
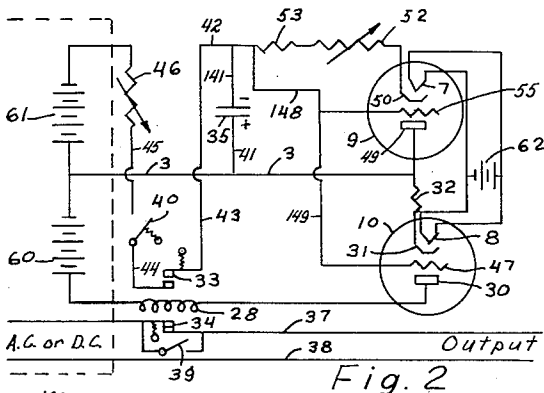
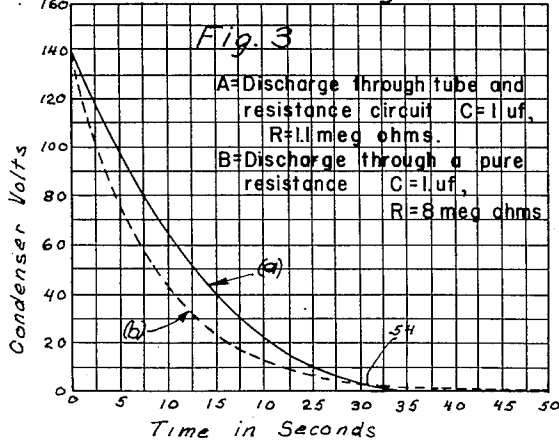
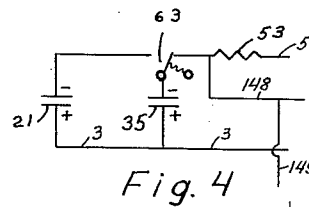
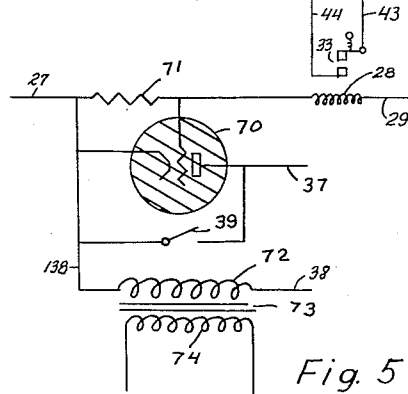
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ELECTRONIC TIMER CIRCUIT

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## UNITED STATES PATENT OFFICE

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## ELECTRONIC TIMER CIRCUIT

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2 Claims. (Cl. 175-320)

This invention relates to timers and more particularly to automatic timers of the electronic type.

5 An object of the present invention is to provide an automatic electronic timer having an infinitesimal number of time periods intermediate fixed maximum and minimum values.

Another object of the invention is to provide in an automatic electronic timer circuit a degenerative discharge circuit in which the tube load is in the cathode circuit in contrast to the so-called pure resistance discharge circuit.

15 A further object of the invention is to provide an automatic electronic timer circuit in which reproducibility of any timing period is easily and expediently accomplished.

Still a further object of the invention is to provide an automatic electronic timer device which may be inexpensively manufactured and maintained at a minimum of cost and attention.

These and other objects are attained by the means described herein and disclosed in the accompanying drawing, in which:

25 Fig. 1 is a diagrammatic circuit illustrating the preferred embodiment of the circuit comprising the present invention.

Fig. 2 is an alternate form of circuit embodying the present invention.

30 Fig. 3 is a comparative condenser discharge curve graph showing a discharge curve through a pure resistance compared with a discharge curve through the circuit comprising the invention.

Fig. 4 is a diagram illustrating an alternative detail of the invention.

35 Fig. 5 is a modification forming a detail of the invention.

With reference to Fig. 1, a suitable source of alternating current, not shown, is adapted to be electrically connected to the circuit shown 40 through a suitable plug 1, having suitable conductors 2 and 3 leading therefrom. A current will flow through conductor 2, through a suitable voltage dropping resistor 4 to cathode heaters 5 of a suitable voltage doubler tube 6. Cathode heaters 5 are in series with the cathode heaters 7 and 8 of tubes 9 and 10 respectively, being electrically connected thereto by conductors 11 and 12. This circuit is completed back to the source of voltage at plug 1 via conductor 3.

50 When cathodes 5, 7 and 8 are heated to the proper temperature, the circuit is ready for operation. It should be noted that in alternate half cycles current will flow through conductor 2, through conductors 13 and 14 to plate 15 of tube 6, through said tube to cathode 16, conductor 17,

to electrolytic condenser 18 thence through conductors 19 and 3 back to the plug 1. Condenser 18 will thereby be charged with the polarities indicated in Fig. 1. On the other alternate half cycles, current will flow from plug 1 through conductors 3 and 20 to electrolytic condenser 21, 5 thence via conductors 22 and 23 to the second plate 24 and cathode 25 of tube 6, through conductor 26 back to plug 1, as shown.

10 Condenser 21 is charged with polarities indicated on the circuit diagram. This circuit will hereinafter be referred to as the power supply circuit.

As the impressed voltage across condenser 18 builds up, current will start to flow through conductor 27, through relay coil 28, conductor 29, to plate 30 thence to cathode 31 of tube 10, thence through a suitable cathode resistor 32, to conductors 3 and 19 back to the other side of condenser 18.

20 At some point, before the voltage across condenser 18 reaches a constant or steady value, enough current will flow through relay coil 28 to operate said relay by closing contacts 33 and opening contacts 34. Contacts 33 are normally open and contact points 34 are normally closed as well known to the art.

It should be noted that when the voltage on condenser 18 reaches a steady value, that the current flowing through tube 10 will be limited 30 only by the self-biasing action of its flow through cathode resistor 32 and the effect of having condenser 35 in the grid circuit of tube 10. This circuit is hereinafter referred to as the output control circuit.

35 This current flow through conductors 27 and 29 is sufficient to energize relay coil 28 whereby the normally open relay contacts 33 in the condenser charging circuit are closed, and simultaneously therewith contacts 34 in the normally closed load circuit are opened, thereby breaking or opening said load circuit. The load circuit comprises conductors 3 and 36 through contacts 34 of relay coil 28, conductors 37 to the load, said circuit being completed back to plug 1 via conductors 38 and 13. It should be noted that this load circuit may be completed through a suitable switch such as 39 in which event said load circuit is not effected by operation of relay coil 28.

50 To initiate a timing cycle, the operator closes a suitable push button switch 40 thereby permitting current to flow from condenser 21 through conductors 20, 3, and 41, to condenser 35, the circuit being completed through conductors 41, 42, and 43 to contacts 33 of the relay, thence through 55

conductor 44 to switch 40 thence through conductor 45 through variable resistor 46 back to the other side of condenser 21 via conductor 22. This charges the condenser 35 with the polarity as indicated in Fig. 1. This circuit is hereinafter referred to as the condenser charging circuit.

As condenser 35 becomes charged a negative bias will be impressed on the grid 47 of tube 10 through conductors 148 and 149. This produces a cut-off current in tube 10, which results in a deenergization of relay coil 28. Contacts 34 of said relay will then be free to close to their normal position thus completing the load circuit and commencing the timing interval. Simultaneously with the closing of contacts 34, relay contacts 33 will open to their normal position thereby interrupting the charging cycle of condenser 35. Due to the inherent inertia of the contacts 33, they will remain closed for an infinitesimal period of time after the cut-off of current occurs in tube 10. Since the inertia effect of the contacts is constant, the time during which condenser 35 is charged will be accurately and faithfully reproduced and repeated every time. Since the time of charging condenser 35 is thus accurately controlled, the quantity of charge thereon can also be controlled by varying the setting of variable resistor 46. Variable resistor 46 provides a very convenient means for compensating for normal variations found in production, thus greatly simplifying the task of calibration. As soon as a potential appears across the plates of condenser 35, current will commence to flow through conductors 41, 3 and 48 to plate 49 of tube 9. This circuit hereinafter referred to as the condenser discharge circuit, is completed to condenser 35 through cathode 50, conductor 51, through suitable resistors 52 and 53 and conductor 141. This current will continue to flow until condenser 35 is completely discharged and the potential of said condenser will vary as shown by curve A in Fig. 3. At some point just before condenser 35 is completely discharged, the negative bias impressed on grid 47 of tube 10 will have been reduced to such a value that enough current will again flow through tube 10 and relay coil 28 to operate said relay whereby contacts 33 are closed and contacts 34 are opened, thereby opening the load circuit. This terminates the timing cycle and resets the circuit for the next operation.

The amount of current that flows through tube 9 and resistors 52 and 53 will, in each instance, depend upon the potential across condenser 35, the resistance of the sum of resistors 52 and 53, and the characteristics of tube 9. Due to the degenerative effect of the voltage drop in resistors 52 and 53, it can be seen that only a very small amount of current will be permitted to flow through the tube 9 with a given potential across condenser 35, for any given type of tube 9 that may be used. Under these conditions the amount of current flowing and therefore, the rate of discharge of condenser 35, can be accurately controlled by varying the resistance of the variable resistor 52. Since the potential drop across resistors 52 and 53 cannot exceed the grid potential at which current cut-off occurs in tube 9, for a given potential on condenser 35, it can be seen that a much smaller resistance 52 and 53 can be used to attain a definite condition of discharge than if a pure resistance and no electronic tube such as 9 is used.

Referring now to Fig. 3, it can be seen that by the use of a tube such as 9, in the condenser

discharge circuit that the amount of resistance required to reach a definite operating point 54 is approximately 14% of that required when no such tube is used in the circuit. Still referring to Fig. 3, it can be seen that the discharge curve is considerably straightened out away from the exponential form found with a pure resistance, as indicated by the broken curve B, whereby the slope of curve A at the operating point 54 is much greater when a tube such as 9 is employed than when just a pure resistance is used. The fact that the rate of change of voltage across condenser 35 with respect to time is greater with the circuit using a tube 9, greatly improves the resultant accuracy over those circuits in which no such tube is used.

The combined resistance of resistors 52 and 53 can be smaller than that required in present day commercial timers using pure resistors in the condenser discharge circuit, and therefore timings up to several minutes duration can be attained with a circuit by using the commercial so-called "volume control" type of resistances which normally are not manufactured in sizes greater than 10 megohms. Since one variable resistor can be used to cover the entire time range desired, it is possible to attain a continuous or infinitesimal range of timings between given maximum and minimum points, thereby eliminating the labor of assembling the multi-tapped switches now in use. Such tapped switches require tedious calibrating for each resistance unit comprising the tapped switch.

In practice, calibration of the timer circuit hereinabove described is accomplished by using a resistor 53 having known characteristics to establish the minimum timing period desired and of then setting variable resistor 52 to the maximum value. A suitable pointer (not shown) secured to the shaft of the variable resistor 52 is then set to indicate the maximum time period on a suitable marked time scale (not shown). Variable resistor 46 is then adjusted to increase or decrease the amount of charge impressed on condenser 35 until the desired maximum time value is obtained. Variable time control resistor 52 is then set to the minimum time value desired and various values of resistor 53 are tried until the desired minimum time period has been obtained. The calibration is now complete and the intermediate points between the maximum and minimum may be correctly and easily calibrated. It should be understood that variable resistor 52 may consist of one or more combinations of variable resistors to give whatever range of time is desired.

An alternate form of power supply is shown in Fig. 2 in which a battery 60 and battery 61 are utilized to replace voltage doubler tube 6, condenser 18 and condenser 21 of Fig. 1. The cathode heaters 7 and 8 of tubes 9 and 10, are now heated by means of a suitable battery 62 placed in series with each as shown. This circuit operates and controls the timing circuit on the same principles as hereinabove described for the circuit shown in Fig. 1.

A modified circuit for charging condenser 35 is shown in Fig. 4, in which variable resistor 46, push button switch 40 and relay contacts 33 are replaced by a single pole double throw non-locking push button switch 63. When switch 63 is pressed, condenser 35 is charged to the full potential of its source. The timing cycle and the discharge of the condenser will not commence until switch 63 has been released. It should be noted

that this method is not the preferred one since it does not afford the ease of calibration present when variable resistor 46, switch 40 and the relay contacts 33, shown in Fig. 1, are used.

5 In the alternate circuit shown in Fig. 5, the circuit has been adapted to use a gas filled triode 70 in lieu of relay contacts 34 for controlling the load circuit. In the circuit shown in Fig. 5, the flow of current through resistor 71, main-  
10 tains a negative bias on tube 70 of such a magnitude that the voltage supplied by the secondary 72 of suitable transformer 73, is not sufficient to form a conducting path through tube 70. When cut-off of current occurs in tube 10, Fig. 1, and  
15 through resistor 71, Fig. 5, the grid voltage on tube 70 becomes zero and current is allowed to flow through conductor 138 to tube 70 and wire 37 back to the load. The return circuit is completed through wire 38 back again to the second-  
20 ary 72 of transformer 73. The primary 74 of transformer 73 is energized by any suitable source of A. C. current, not shown. It should be understood that relay coil 28 is still utilized to operate contacts 33 of the condenser charging  
25 circuit.

As used herein the term degeneration or degeneratively applies to feed back.

From the foregoing, it is apparent that I have provided a fully automatic electronic timer in  
30 which one variable element, (variable resistor 46) may be utilized to compensate for any differences in the circuit constants, viz., tubes 9 and 10, resistors 52 and 53 and condenser 35. This feature greatly simplifies the time required to  
35 calibrate electronic timers, since each timer must necessarily, because of the allowable variation in tubes, resistors and condensers, be individually calibrated.

I have likewise provided by simple, readily  
40 available means, an electronic timer in which the discharge characteristics of the condenser in the "time circuit" have been improved by placing a suitable multi-element tube, in series therewith, whereby said condenser is discharged with im-  
45 proved characteristics than would be the case if a pure resistance were used, as is now customary. This feature greatly improves the accuracy of reproducibility of timing cycles or periods, as shown graphically in Fig. 3.

50 It should also be noted that by reason of multi-element tube 9 in the timer circuit, a smaller resistance may be used than would otherwise be necessary to obtain an equal timing interval. This is a distinct advantage since it permits the  
55 use of the commercial "volume control" type continuously variable resistors. These commercial resistors are usually manufactured in the magnitude of 3 megohms.

Experiments have shown that a 3 megohm variable resistor 52 will produce time periods up to  
60 several minutes when the capacity of timer condenser 35 is but one microfarad.

It should also be noted that these advantages of my discharge timing circuit are based pri-  
65 marily on the regenerative action which results from placing the tube load in the cathode circuit whereby the constant current discharge principle is used.

What is claimed is:

70 1. In an electronic timer of the class described comprising a power supply circuit, a condenser charging circuit, a condenser discharging circuit and an output control circuit, said condenser charging circuit comprising a manually operated,  
75 normally open switch and a pair of normally

open electrically operable contacts and a con-  
denser, said condenser adapted to be impressed  
with a charge from said power supply circuit  
when said manually operable switch is actuated,  
said output control circuit comprising a tube in-  
5 cluding a plate, grid and cathode and a current  
responsive means in the plate circuit thereof,  
said output control circuit being normally ener-  
gized from a suitable source of power for closing  
10 said normally open contacts in said condenser  
charging circuit and for normally maintaining  
an open load circuit, said condenser discharge  
circuit comprising an electron tube including  
a plate, grid and cathode having a resistance in  
15 the cathode circuit thereof, the negatively  
charged terminal of said condenser being elec-  
trically connected with the grids of each of said  
tubes, the positively charged condenser terminal  
being connected to the plate of the condenser dis-  
20 charge circuit tube and to the cathode of the  
tube in said output control circuit so that as the  
charge builds up on said condenser, a negative  
bias is impressed upon the grid of the output control  
circuit tube for reducing the current flowing  
25 through said current responsive means in the  
plate circuit thereof for closing said normally  
open load circuit and of simultaneously opening  
said electrically operable contacts in said con-  
30 denser charging circuit to disconnect said con-  
denser from said power supply circuit, the charge  
upon said condenser being dissipated through  
said discharge circuit, the rate of condenser dis-  
charge being governed by the amount of resist-  
35 ance in the cathode circuit of the tube in said  
condenser discharge circuit, current flow being  
re-established to said current responsive means  
as the negative bias impressed on the output  
control circuit tube is decreased by the discharge  
40 of said condenser through said condenser dis-  
charge circuit to open said load circuit and to  
simultaneously close the normally open elec-  
trically operable contacts in said condenser  
charging circuit.

2. In an electronic timer of the class described  
comprising a power supply circuit, a condenser  
charging circuit, a condenser discharging circuit  
45 and an output control circuit, said condenser  
charging circuit comprising a variable resistor, a  
manually operated, normally open switch and  
a pair of normally open electrically operable con-  
50 tacts and a condenser, said condenser adapted to  
be impressed with a charge from said power supply  
circuit when said manually operable switch is  
actuated, said output control circuit compris-  
55 ing a tube including a plate, grid and cathode  
and a current responsive means in the plate circuit  
thereof, said output control circuit being  
normally energized from a suitable source of  
power for closing said normally open contacts in  
60 said condenser charging circuit and for normally  
maintaining an open load circuit, said con-  
denser discharge circuit comprising an electron  
tube including a plate, grid and cathode having a  
resistance in the cathode circuit thereof, the neg-  
65 atively charged terminal of said condenser being  
electrically connected with the grids of each of  
said tubes, the positively charged condenser terminal  
being connected to the plate of the con-  
denser discharge circuit tube and to the cathode  
70 of the tube in said output control circuit so that  
as the charge builds up on said condenser, a  
negative bias is impressed upon the grid of the  
output control circuit tube for reducing the cur-  
rent flowing through said current responsive  
75 means in the plate circuit thereof for closing