

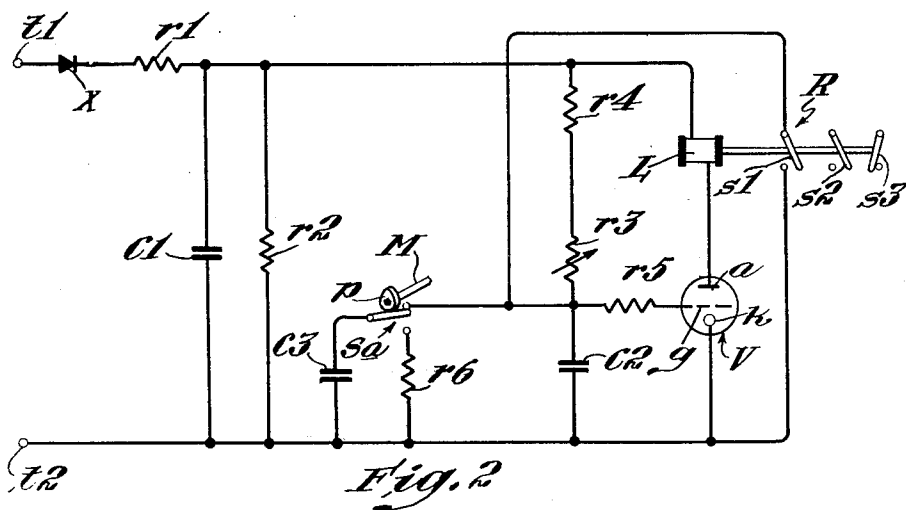
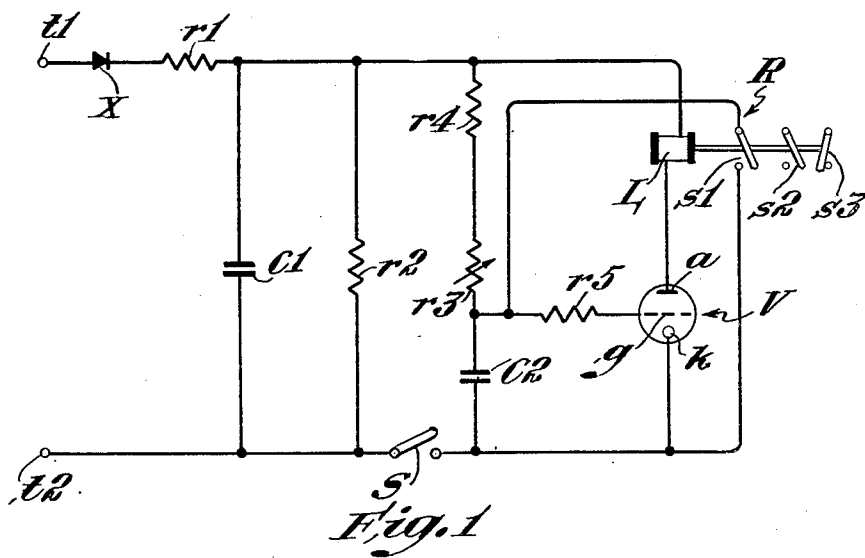
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COLD CATHODE TIMER

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## COLD CATHODE TIMER

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This invention relates to electrical time delay apparatus and more particularly to apparatus of the type which uses the time constant of a reactive circuit for determining a time interval.

Objects of this invention are to provide an electrical time delay apparatus which is operable from either a direct or an alternating source of power, which does not require power during stand-by periods, which is not subject to false operation during voltage fluctuations of the power source, which does not require a starting switch, which may be used as an underspeed indicator, which automatically resets itself at the termination of a timing interval, which permits immediate recycling, which is continuously and readily adjustable for timing intervals of different lengths, which can be adjusted during the timing cycle, which is simple, rugged and economical in design and construction, which requires a minimum of moving parts, which has a long life, which uses conventional circuit components, and which advances generally the art to which it is related.

In one aspect the invention contemplates an electronic timing device comprising a relay having an operating solenoid connected in series with the anode and cathode of a vacuum tube across two terminals adapted to be connected to a power supply for the device. A control network including a reactor is connected to the tube control electrode and to the terminals so that the reactor, which may be either a capacitor or an inductor, is energized upon the connection of the terminals to the power source thus starting the timing interval. After the elapse of a time interval determined by the time constant (i. e. RC or L/R) of the circuit, the potential across the reactor, which is applied to the control electrode of the tube, reaches the striking potential of the tube. When such potential is reached the tube conducts thereby to operate the solenoid of the relay transferring its load contacts to complete the timing interval.

In another aspect a rectifying network is interposed between the input terminals and the tube and control network thus making it possible to energize the device from either a direct or an alternating power source. A further feature is the use of a tube having a cold cathode so that the device is always available for use from a cold start without the necessity of either a delay while the tube heater warms up or of drawing heater current during stand-by periods. A further feature of the invention is the use of one pair of normally open contacts which are closed upon the

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energization of the relay solenoid at the end of the timing interval thereby to short circuit the capacitor and thus automatically discharging the capacitor so that the device is ready immediately to start a succeeding timing cycle.

Another aspect of the invention is the use of a switch which alternately connects an auxiliary capacitor in parallel with the timing capacitor and then discharges the auxiliary capacitor, for example by connecting it across a bleeder resistor whereby sufficient charge is siphoned from the timing capacitor so that the potential thereacross does not reach the striking potential of the tube. By correlating the operation of the switch with that of a machine, for example by the rotation of a shaft or a cam, or by a reciprocating member, the closing of the relay by the nonoperation of the switch can be utilized to sound an alarm or shut off the power supplied to the machine. By proper proportioning of the circuit elements, the relay can also be made to operate when the speed falls below a predetermined value.

These and other objects, aspects and features will be apparent from the following description of two illustrative specific embodiments of the invention referring to a drawing in which

Fig. 1 is a circuit diagram of one embodiment of the invention wherein a relay is operated after a predetermined time interval; and

Fig. 2 is a circuit diagram of a second embodiment of the invention wherein a relay is operated when the rotation speed of a shaft falls below a predetermined value.

In the embodiments shown in Fig. 1, two terminals  $t1$  and  $t2$  are provided which are adapted to be connected to a conventional source of electrical power (not shown). Connected between the terminals  $t1$  and  $t2$  is a rectifying network comprising a half wave rectifier X, for example of selenium, and filtering elements including a resistor  $r1$  one end of which is connected to the terminal  $t1$  by the rectifier X and a capacitor  $c1$  which is connected between the other terminal of the resistor  $r1$  and the terminal  $t2$ . A bleeder resistor  $r2$  having a relatively high ohmic value is connected in parallel with the capacitor  $c1$ . Coupled to the common junction of the resistor  $r1$  and the capacitor  $c1$  is one end of an operating solenoid L of a relay R having a plurality of contacts  $s1$ ,  $s2$  and  $s3$ . The opposite end of the solenoid L is coupled directly to the anode  $a$  of a vacuum tube V whose cathode  $k$  is connected to the power source terminal  $t2$  by the closing of a switch S. The vacuum tube V is, for example,

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either of the gaseous types designated 1C21 or OA4G which have a cold cathode *k* so that the device is always ready for operation without the delay required for a cathode heater to warm up.

Connected between the common junction of the resistors *r1* and *r2* and the power supply terminal *t2* is a control network comprising a timing capacitor *c2* in series with resistors *r3* and *r4* one of which such as *r3* is an adjustable potentiometer. The common junction of the capacitor *c2* and the resistor *r3* is connected to the control electrode *g* of the tube *V* by a coupling resistor *r5* so that the potential developed across the capacitor by any charge therein is applied between the control electrode and cathode of the tube. The capacitor *c2* is also connected in parallel with one pair *s1* of normally open load contacts of the relay *R*.

The input terminals *t1* and *t2* may be connected to either a direct or alternating source of power; in either case a direct potential being developed across the resistor *r2*. The timing interval is started by the closing of the switch *S* which applies such direct potential between the cathode *k* and the control electrode *g* of the tube *V* and simultaneously energizes the control network. The timing capacitor is charged by the direct potential through the resistors *r3* and *r4* at a rate determined by the adjustment of the potentiometer *r3*. The potential developed across the capacitor *c2* by the charging thereof is applied between the cathode *k* and the control electrode *g* of the tube *V*. When the capacitor *c2* has been charged sufficiently so that a potential equal in magnitude to the striking potential of the tube *V* is applied to the control electrode *g*, the tube conducts. The resulting flow of current in the tube anode circuit energizes the relay solenoid *L* thereby transferring the contacts *s1*, *s2* and *s3* to complete the timing interval. The load contacts *s2* and *s3* operate to modify conditions in external load circuits (not shown). The conjoint closing of contacts *s1* discharges the capacitor *c2* thereby preparing it for the next timing cycle. As the control electrode *g* loses control after the tube *V* fires, the drop in potential by the discharge of the capacitor has no effect thereupon. The relay *R* and tube *V* are deenergized by opening the switch *S* thereby to reset the relay for the next timing cycle.

It is also possible to maintain switch *S* in the closed position and start the timing interval by applying power to the input terminals *t1* and *t2*. This method of operation introduces a small timing error due to the time constant of the rectifying network, but has the advantage of eliminating standby losses in such network. After capacitor *c1* has been charged the operation of the circuit is similar to that described in detail heretofore with reference to the function of switch *S*. The relay *L* in this instance is deenergized by disconnecting the power source from terminals *t1* and *t2*. After the power has been disconnected the filter capacitor *c1* discharges through the bleeder resistor *r2*.

A second embodiment of the invention is shown in Fig. 2 wherein a circuit analogous to the circuit shown in Fig. 1 is used as a low speed indicator or governor for a machine of which only a shaft *M* is shown. The circuit elements of the rectifying network, the relay *R* and the vacuum tube *V* are analogous in operation and bear similar indicia to corresponding circuit elements in Fig. 1. Two resistors *r3* and *r4* are again connected in series with a timing capacitor *c2* be-

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tween the input terminal *t2* and the junction of resistors *r1* and *r2*. The control network in Fig. 2 in addition incorporates a second auxiliary capacitor *c3* which is connected in parallel with the timing capacitor *c2* by the closing of a switch *Sa*. The switch *Sa* is operated by the rotation of the shaft *M* and may be of any conventional construction, for example, a centrifugal or rotary switch having two contacts which alternately close during the operation. This switch *Sa* is shown schematically as a double-throw single-pole switch operated by a cam *p* located upon the end of the shaft *M* although it is to be understood that the switch could as well be operated by a reciprocating member or any of the other well known mechanisms. In the position of the switch *Sa* illustrated, the capacitor *c3* is connected in parallel with the timing capacitor *c2*. In the alternate position of the switch *Sa*, the capacitor *c3* is connected across a bleeder resistor *r6* of low value.

When the shaft *M* is rotating, the periodic closing of one contact of the switch *Sa* connects the capacitor *c3* in parallel with the timing capacitor *c2*, thereby to siphon off the accumulating charge so that the potential across the capacitor *c2* never rises to the striking potential of the tube *V*. The charge accumulating in capacitor *c3* is leaked off through the bleeder resistor *r6* by the periodic closing of the other switch contact. If the shaft *M* stops in any position, the charge builds up in the timing capacitor *c2*, or in capacitors *c2* and *c3* depending upon the position in which switch *Sa* stops, until the striking potential of the tube *V* is reached whereupon the relay solenoid *L* is energized in a manner similar to that described in detail in connection with the operation of the embodiment shown in Fig. 1. The relay contacts *s2* and *s3* operated to sound an alarm or to shut down the machine.

It is also possible to proportion the circuit elements so that the charge in the timing capacitor *c2* accumulates until the tube striking potential is reached whenever the rotational speed of the shaft *M* falls below a predetermined value. Below the predetermined speed of shaft *M*, the operation of the switch *Sa* is too infrequent to remove the charge from the timing capacitor *c2* as fast as such charge is accumulating so that the potential builds up to the striking potential of the tube *V*. By proper design of the cam *p*, for example by notching, it is possible to obtain reliable operation in the order of 4 R. P. M., a speed far below that at which conventional centrifugal underspeed devices operate satisfactory.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents which fall within the scope of the appended claims.

I claim:

1. A device responsive to speed, such as underspeed, of a machine, comprising two terminals for connection to a power supply; a vacuum tube having an anode, a cathode and a control electrode; a relay having a plurality of contacts and a solenoid for transferring the contacts, the solenoid being connected in a circuit containing said anode, said cathode and said terminals; a control network including a timing capacitor, means for energizing said capacitor from said terminals, and means for connecting said capacitor between said circuit and said control electrode for applying to the electrode the potential developed across the capacitor; and means operated by

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said machine for periodically discharging the capacitor so that the potential of the capacitor charge is limited to a value below the striking potential of the tube dependent upon the operating rate of the machine.

2. A device responsive to speed, such as under-speed, of a machine, comprising two terminals for connection to a power supply; a vacuum tube having an anode, a cathode and a control electrode; a relay having a plurality of contacts and a solenoid for transferring the contacts, the solenoid being connected in a circuit containing said anode, said cathode and said terminals; switching means operated by said machine; a control network including a timing capacitor connected in series to said terminals, a resistor, means for connecting said timing capacitor through said resistor between said circuit and said control electrode for applying to the electrode the potential developed across the capacitor, a bleeder resistor, and a second capacitor, said bleeder resistor and second capacitor being connected to one side of said timing capacitor; and connections between said switching means, said second capacitor, said bleeding resistor and the other side of said timing capacitor for putting said second capacitor in parallel with the timing capacitor in one position of said switching

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means and for putting said bleeder resistor across said second capacitor in another position of said switching means, said second capacitor diminishing the charge of the timing capacitor in said first position of the switching means and said bleeder resistor discharging the second capacitor in the other position of the switching means, so that the charge of the timing capacitor is limited to a value below the striking potential of the tube dependent on the operating rate of the machine.

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