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DELAY OR OSCILLATING CIRCUITS

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Fig. 1.

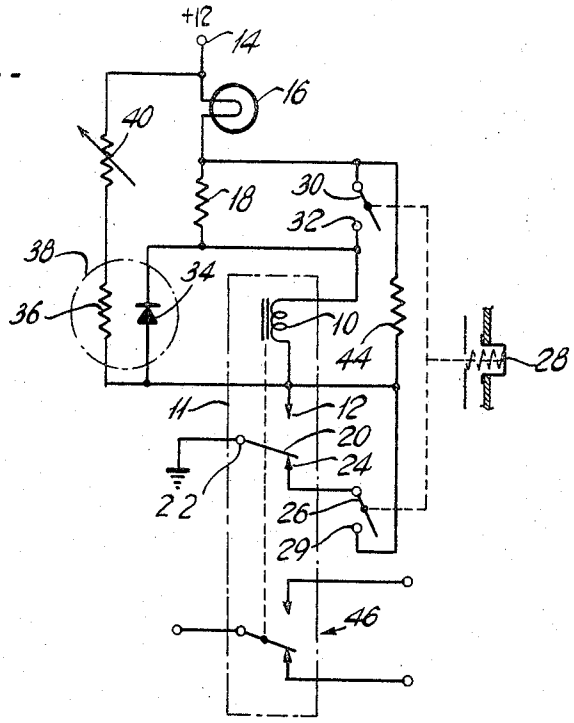
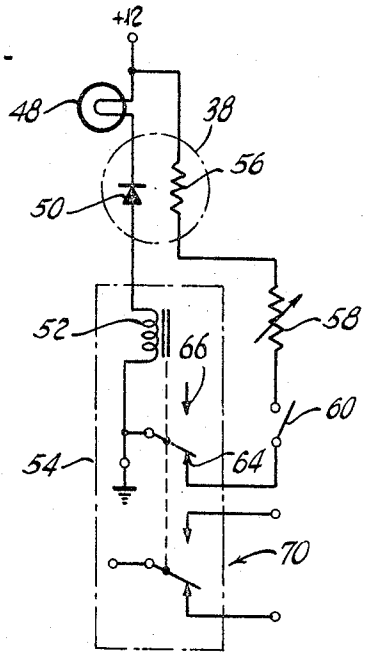


Fig. 2.



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DELAY OR OSCILLATING CIRCUITS

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ABSTRACT OF THE DISCLOSURE

A time delay circuit is described employing a semiconductor diode, a heater and a relay. The diode is reversely connected so that it conducts no current at room temperature. When the diode is heated, it breaks down and conducts current so as to shunt the relay winding and thereby deenergize the relay. The action of the relay armature is used to control other circuits.

The present invention relates to delay and oscillating circuits, primarily those employing relays, and provides such circuits which have long periods of delay and oscillation, respectively.

In accordance with the present invention long period delay and low frequency oscillating circuits are provided which are compact, simple, reliable, very inexpensive and readily adjustable. Generally speaking, each of these circuits has an energization circuit including a back-biased diode with a heater coil wrapped around it for heating the diode to change the diode's reverse resistance. In operation of the particular delay or oscillating circuit, the period of the delay or oscillation is controlled by the change in current flow through the diode caused by the change in the diode's reverse resistance due to heating the diode with heat from the heater coil. Since the rate at which the diode is heated by the heater coil is determined by the magnitude of the current flow through the heater coil, this means that the desired period of delay or oscillation in the operation of the circuit can be set by control of the current flow through the heater coil.

For a better understanding of the present invention and the particular novel features thereof reference should be had to the accompanying claims and to the following description of two embodiments of the invention which should be read while referring to the accompanying figures of which:

FIG. 1 is a schematic diagram of a delay circuit which will switch into one state upon pressing a button and will automatically switch back to its initial state after a selectable period of time; and

FIG. 2 is a schematic diagram of an electromechanical oscillator.

In the embodiment of the invention shown in FIG. 1, the coil **10** of a relay **11** is connected between a normally open contact **12** of the relay and the positive terminal **14** of a 12 v. DC supply in series with a lamp bulb **16** and a resistor **18**. The armature **20** of the relay **11** associated with this normally open contact **12** is connected to the grounded terminal **22** of the 12 v. DC supply and is normally positioned against a contact **24** which is connected to one arm **26** of a two arm push button switch **28**. When the push button **28** is depressed this arm **26** contacts a normally open terminal **29** of the switch **28** which is connected to the normally open contact **12** of the relay.

The second arm **30** of the push button **28** is connected to one side of the resistor **18**. When the push button is depressed this second arm **30** contacts a second normally open terminal **32** of the switch **28** which is connected to the other side of the resistor **18**. Therefore, when the push button **28** is depressed current will flow from the positive

terminal **14** through the lamp **16**, the arm **30** of the push button **28**, coil **10** of the relay, the arm **26** of the push button **28**, the contact **24** and the armature **20** of the relay to the grounded terminal **22**. This current flow energizes the relay **11** causing the armature **20** to move away from contact **24** and against normally open contact **12**, so that current flows through the normally open contact **12** and the armature **20** of the relay to the grounded terminal **22** instead of through arm **26** of the push button **28** and contact **24** and the armature **20** of the relay.

When pressure is taken off the push button **28** the arms **30** and **26** move away from the contacts **32** and **29**. However, the relay **11** remains energized because current flow from the positive terminal **14** through the lamp **16**, resistor **18**, the coil **10**, the normally open contact **12** and the armature **20** of the relay to the grounded terminal **22** of the supply is sufficient to maintain energization of the relay **11**.

Connected in shunt with the coil of the relay is a semiconductor diode **34** which is back-biased by the potential across the coil **10** of the relay **11**. Wrapped around the diode is a heater coil **36** and the heater coil and the diode are set in a heat conducting material **38** for maximum heat transference from the coil **36** to the diode **34**. The heater coil **36** is connected, across the lamp **16**, the resistor **18** and the coil **10** of the relay, in series with a variable resistor **40**. Therefore, before the push button was depressed the heater coil did not heat the diode because the circuit through the heater coil **36** between the terminals **14** and **22** was incomplete. However, when the relay is energized and the armature **20** is against the contact **12**, the heater coil is connected across the terminals **14** and **22** in series with the variable resistor **40**. Thus current flows through the heater coil and starts heating up diode **34**. As the diode heats up it finally reaches a point where it breaks down in its backward direction allowing current to flow freely through the diode in the reverse direction. This means that current will now flow through the lamp **16**, the resistor **18**, the diode **34** and the normally open contact **12** and armature **20** of the relay to the grounded terminal **22**, bypassing the coil **10** of the relay. This current flow through the diode **34** is sufficient to deenergize the relay **11**, thus causing the armature **20** to fall away from the normally open contact **12** and against the normally closed contact **24**. This means that the circuit across the coil **10** and the heater **36** is broken since the arm **26** of the push button **28** does not complete the circuit through contact **24** to ground unless the push button is depressed. Thus the relay **11** remains deenergized and current no longer flows through the heater **36** so that the diode **34** starts cooling to return the circuit of FIGURE 1 to its initial condition.

The length of time the relay **11** remains energized is determined by the magnitude of the current flow through the heater coil which in turn is determined by the setting of the variable resistor **40**. In one application, the length of time for which the relay **11** remains energized can be changed from approximately 21 seconds to 1 minute and 40 seconds by changing the position of the variable resistor **40** from its minimum setting to its maximum setting.

The purpose of the lamp **16**, the resistor **18** and another resistor **44** which are connected across resistor **18** and the coil **10** is to obtain a difference in the current flow through the coil **10** which will expedite energization of the relay and at the same time make the deenergization of the relay relatively easy.

When the push button **28** is first depressed the lamp **16** is cold and therefore its resistance is low. At the same time the armature **30** shunts resistor **18** so that for all practical purposes the coil **10** is connected directly across the 12 v. DC supply. This means that it receives a maxi-

mum energization current. However, when the push button **28** is no longer depressed resistor **18** is again inserted in series with the coil **10**. Also as current flows through it, lamp **16** heats up and its resistance increases. Both the addition of resistor **18** into the energization path and the increase in resistance of the lamp **16** decreases current flow through coil **10**. With this decreased current flow through coil **10**, the change in current through the coil necessary to deenergize the relay **11** is smaller than would be necessary to deenergize the relay right after it has been energized and is receiving maximum energization current.

As shown, a second set of contacts **46** may be employed to control current flow to devices as a function of the energization and deenergization of the coil **10**.

Referring to FIG. 2, a lamp **48**, a diode **50** and the coil **52** of a relay **54** are connected in series between the positive and grounded terminals of the 12 v. DC supply. The diode **50** is back-biased by this supply so that current cannot flow therethrough and through the coil **52** of the relay to energize the relay **54**, thus the relay normally is unenergized. Also connected between the positive and ground terminals to the 12 v. DC supply is a series circuit including a heater coil **56** which is wrapped around the diode **50**, a variable resistor **58**, a normally open switch **60**, an armature **62** of the relay **54** and the normally closed contact **64** of that armature.

When the switch **60** is closed it means that current will flow through the heater coil **56** between the positive and negative terminals, heating the diode **50**. Eventually, as is the case of the circuit in FIG. 1, the diode is heated sufficiently so that it breaks down in its reverse direction, allowing current to flow through it, the lamp **48**, and the coil of the relay **54**, energizing the relay. With the relay energized it attracts the armature **62** away from the normally closed contact **64** and towards a normally open contact **66**, thus breaking the energization circuit for the heater **56**, so that current can no longer flow through heater **56**. This means that the heater **56** will start cooling allowing the diode **50** to cool and cut off the current flow through the coil **52** of the relay, deenergizing the relay. This completes the circuit through the heater **56** starting another cycle as described above. It can be seen that with this circuit the relay will alternatively be energized and deenergized as the electric circuit through the heater **56** is alternatively made and broken by the energization and deenergization of the relay with the result that this circuit functions as an electromechanical oscillator.

As in the case of circuit of FIG. 1, the lamp **48** aids in deenergizing the relay by heating up and cutting down the current flow through the coil **52** once the relay is energized.

The period of oscillation can be controlled by resistor **58** since this resistor determines the magnitude of the current flowing through the heater **56** and thus determines the length of time it takes to heat the diode until it breaks down. When it is desired to stop the oscillation of the armature **62** between contacts **64** and **66**, all that is necessary is to permanently break the circuit through the heater by reopening the switch so that once the diode cools, oscillation will stop.

A second set of contacts **70** is provided for controlling the current flow through a circuit as a function of the oscillation of the energization and the deenergization of the coil of the relay **52**.

Above two embodiments of the present invention have been described. However, it should be apparent to those skilled in the art that variations and modifications in the above described embodiments can be made without departing from the spirit and scope of the invention. Therefore, it will be understood that this covers all modifications and changes of the above described embodiments which do not depart in spirit and scope from the above described invention as embodied in the appended claims.

What is claimed is:

1. A time delay circuit comprising:

(1) a source of direct current potential,

(2) a relay including a winding, at least two normally open contacts, and at least two normally closed contacts,

(3) an operating circuit for energizing said relay and latching it in its operated condition,

(4) a semiconductor diode connected in parallel with said winding and poled so as to be nonconductive, and

(5) an electrical heater for said diode,

whereby the actuation of said relay closes the normally open pair of contacts and applies current to the heater to render said diode conductive after a predetermined time interval, thereby shunting said winding and de-energizing said relay.

2. The time delay circuit of claim **1** including a variable resistor connected in series with the electrical heater to vary the time interval during which the relay remains energized.

3. A time delay circuit according to claim **1** wherein said operating circuit includes ganged switching means which, when momentarily closed, is operative to momentarily energize said winding of said relay, thereby closing a series path from the power source through said winding and an armature of said relay to ground.

4. A time delay circuit according to claim **1** wherein said ganged switching means are actuated by pushbutton means.

5. A time delay circuit according to claim **1** wherein said circuit includes a non-linear resistance element in series with said winding of said relay.

6. An electromechanical oscillator comprising:

(1) a power source;

(2) a relay having at least one armature, a winding and at least one contact associated with each armature;

(3) an energizing circuit for said relay including;

(a) a solid-state diode connected in series with said winding;

(b) heating means associated with said diode and connected in series between said power source and a normally closed contact of said relay, and through the armature of said relay to ground;

(c) switching means connected in series between said heating means and said normally closed contact.

7. The electromechanical oscillator of claim **6** wherein a variable resistance is connected in series between said heating means and said switching means.

8. The electromechanical oscillator of claim **6** wherein a non-linear resistance is connected in series between said power source and said diode.

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