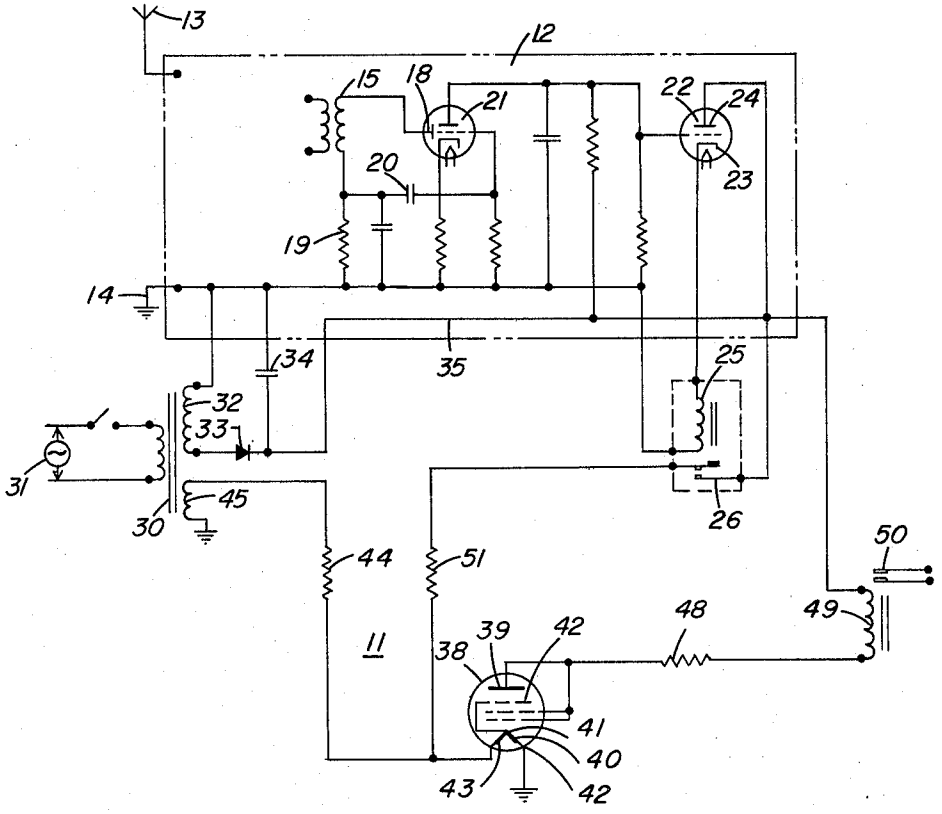
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THERMAL TIME DELAY

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THERMAL TIME DELAY

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The invention relates in general to time delay circuits and, more particularly, to radio circuits incorporating a thermal time delay to avoid response to spurious energy.

Many radio circuits have need for some form of time delay in various portions of the circuit and one such use is to avoid response to spurious energy, such as that contained in lightning, which otherwise might trigger the radio circuit to give a false signal. A more specific use for the invention described herein is in radio controlled garage door operators, wherein a carrier containing a lower frequency intelligence may be transmitted as a signal. This lower frequency intelligence may be in the form of modulation on the carrier wave or it may be in the form of an interrupted carrier wave at a specified rate, for example a sub-audio frequency. This carrier wave with contained intelligence is broadcast, usually by a short-range portable transmitter, to a receiver having circuits designed to receive this particular combination of carrier and intelligence component. Various carrier frequencies and various modulation frequencies permit many combinations to permit private operation for security. The receiver is tuned to the particular carrier frequency and has a detector to obtain the intelligence frequency. When the combination of carrier and intelligence frequency is correct, this signal is passed by the receiver to a pilot relay which is energized to control actuation of the garage door operator. Such systems have been used in the past but have been subject to spurious operation by random atmospheric disturbances and, more particularly, lightning flashes. The latter is an arc discharge containing many random frequencies and, of course, at high amplitude. The energy received by the receiver from such lightning flashes is often sufficient to pass a certain portion at the frequency of the intelligence component to actuate the pilot relay.

Accordingly, an object of the invention is to provide a time delay so that random atmospheric disturbances, such as lightning, will not actuate the pilot relay of such a radio receiver.

Another object of the invention is to provide an electronic circuit for use with a signal voltage wherein a thermal time delay circuit is provided which includes a thermionic tube having an anode and a cathode including a filament. Output means is connected in circuit with the anode and cathode and a filament voltage source is connected to at least part of the filament to energize same at a value insufficient to raise the cathode to normal electron emission, and means is provided connecting at least part of the filament to be energized in accordance with the signal voltage whereby, after a time delay, the cathode is raised to substantially normal emission to cause conduction of the thermionic tube.

Another object of the invention is to provide a thermal time delay depending upon the thermal lag in emission characteristics of a thermionic tube.

Another object of the invention is to provide a thermal time delay circuit including a first means to partially heat a cathode and a second means to heat the cathode still further to obtain normal emission after a time delay.

Another object of the invention is to provide a dual heat source for a thermionic tube filament with one heat source providing initial partial heating of the filament and the second source providing a time delay before heating of the filament sufficient to cause effective conduction of the thermionic tube.

Other objects and a fuller understanding of this invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawing, in which:

The single figure of the drawing shows a radio circuit incorporating the thermal time delay circuit of the invention.

The drawing shows a thermal time delay circuit **11** as incorporated in part of a radio circuit **12**. This radio circuit **12** may be in the form of a radio receiver receiving energy on an antenna **13** relative to ground **14**. The radio receiver **12** may include the usual forms of amplification, amplifying the energy by amplifiers, not shown, and supplied to a transformer **15**. The radio receiver **12** may be, for purposes of example, one usuable with a remotely controlled garage door operator. A transmitter, not shown, transmits a carrier containing a low frequency intelligence, such as a low frequency modulation component, or a carrier interrupted at a lower frequency, such as a sub-audio frequency. This carrier and intelligence component is received on the antenna **13** and amplified, and appears at the transformer **15**. This transformer passes the carrier to a detector **18** which develops the intelligence component across a detector load resistor **19**. This intelligence component is passed by a capacitor **20** to an amplifier **21** which, in turn, passes the amplified intelligence component or signal voltage to another amplifier **22**. This amplifier has a cathode **23** and an anode **24** connected in circuit with a demodulator relay **25**. This demodulator relay **25** is connected as a cathode follower in the circuit of the amplifier **22**. The demodulator relay **25** has contacts **26** adapted to be closed when the demodulator relay **25** is energized, and is in the form of a tuned relay, so that the contacts **26** are actuated at the frequency of the intelligence component so long as this intelligence component received on the antenna **13** is the same as the frequency to which the relay **25** is tuned.

The radio circuit **12** includes a power transformer **30** energized from an alternating current source **31**. A high voltage secondary **32** supplies a voltage through a rectifier **33** and a capacitor **34** to supply a direct current operating voltage on conductor **35**. This supplies operating voltages for the amplifiers **21** and **22**.

A thermionic tube **38** is provided with an anode **39** and a filamentary cathode **40**. This filament **40** is in two sections connected in series at a midtap **41** which is internally connected to a suppressor grid **42**. This thermionic tube **38** is shown as a pentode, but with the control and screen grids both tied to the anode **39** so that this tube **38** acts as a diode. One end **42** of the filament **40** is connected to ground and the other end **43** is connected through a current dropping resistor **44** to a secondary **45** on the transformer **30**, which acts as a filament supply voltage source. This secondary **45** supplies the filament voltage to the amplifiers **21** and **22** which may be 6.3 volt filament tubes and, accordingly, the current dropping resistor **44** is used to lower the voltage and, hence, current to the filament **40** to a value insufficient to establish effective conduction through the thermionic tube **38**. The anode **39** is connected through a resistor **48** and a pilot relay winding **49** to the positive direct current operating voltage source on conductor **35**. The pilot relay has contacts **50** which will be closed upon sufficient energization of the pilot relay winding **49**. A voltage dropping resistor **51** is connected from the end **43** of the filament **40** through the demodulator relay contacts **26** to the positive direct current source on conductor **35**.

The thermionic tube **38** provides a thermal time delay

in the order of ⅛ to 1 second before pull-in of the pilot relay contacts **50**. It has been found that a type 3V4 tube is satisfactory for the thermionic tube **38**. This tube happens to be a power pentode and in the particular application shown, it is connected as a diode. The 3V4 tube has two 1.4 volt sections of the filament connected in series for a 2.8 volt filament operation or, alternatively, the two sections may be connected in parallel for 1.4 volt operation. The midtap **41** has an external pin connection for this purpose. The current dropping resistor **44** drops the current through the filament **40** to about half normal current which heats the filament but does no raise it to the temperature of effective electron emission. However, when an incoming signal is received on the antenna **13**, it is detected at the detector **18** and amplified and applied to the demodulator relay **25**. If this intelligence component agrees with the frequency to which the relay is tuned, the contacts **26** will vibrate at that particular incoming frequency, e.g., 20 cycles. This periodic actuation of the contacts **26** applies an interrupted high voltage through the voltage dropping resistor **51** to the filamen **40**. Assuming that the contacts **26** are closed 40% of the time, the impedance of the resistor **51** will be so selected in accordance with the voltage on conductor **35**, so as to raise the filament temperature to approximately normal temperature for efficient and normal electron emission. This takes a certain finite time, e.g., ¼ of a second, and then the thermionic tube **38** conducts to cause pull-in of the pilot relay contacts **50**. Thus, the time required to heat the filament to achieve effective electron emission establishes a time delay period before actuation of the relay contacts **50**.

This thermal time delay circuit has many applications and, in particular, it is useful in the circuit shown, wherein the radio receiver **12** is subject to receiving random or spurious interference such as energy from lightning. Such spurious interference often contains energy at very many frequencies and it is always possible that the energy received might contain sufficient energy at both the selected carrier and intelligence frequencies so that it will be passed to the demodulator relay **25** and actuate such demodulator relay contacts for one or two cycles. At the sub-audio frequency of intelligence given above as an example, namely, 20 cycles, it will take five periodic actuations of the demodulator relay contacts **26** before sufficient additional heat has been imparted to the filament **40** to cause pull-in of the pilot relay contacts **50**. This is assuming ¼ of a second delay. The length of the time delay may be decreased by increasing the temperature of the filament **40** as determined by the filament supply source **45** and current dropping resistor **44**. Alternatively, the voltage of the secondary voltage source **35** may be increased or the value of the voltage dropping resistor **51** may be decreased to apply an over-voltage on the filament **40** to rapidly bring the thermionic tube **38** to effective electron emission levels. In garage door operator service, the modulated carrier wave from a transmitter is generally transmitting for only a few seconds and, accordingly, any over-voltage applied to the filament **40** would only be for a few seconds so as not to be harmful. Of course, the time delay may be increased by decreasing the amount of continuous heat on the filament **40** or by decreasing the amount of additional heat supplied through the demodulator relay contacts **26**, or by using a cathode sleeve-type thermionic tube which will have an increased thermal lag.

The secondary **45** is a first voltage source to at least partially energize the filament **40** or to apply a voltage to at least part of this filament. The secondary **32** and rectifier **33** supplying a positive direct current voltage is a secondary voltage source to supply a voltage which at least partially energizes the filament **40** or to supply a voltage to at least a part of the filament **40**. The first voltage source **45** and resistor **44** are insufficient to establish normal electron emission from the filamentary cathode **40**, and the second source in combination with the first source, is sufficient to establish substantially normal electron emission. Accordingly, the invention shows the use of dual voltage sources applied selectively to obtain a thermal time delay circuit.

Although this invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. In a radio receiver circuit for use with a carrier wave having a lower frequency intelligence thereon, a thermal time delay circuit including contact means actuated in accordance with said lower frequency intelligence, a thermionic tube having an anode and a cathode, output means connected in circuit with said anode and said cathode, first means including a first voltage to partially heat said cathode, and second means including a second voltage and responsive to said lower frequency intelligence to heat the cathode through said contact means still further to obtain normal electron emission after a time delay.

2. In an electronic circuit for use with a signal voltage, a thermal time delay circuit including contact means actuated in accordance with said signal voltage, a thermionic tube having an anode and a cathode including a filament, output means connected in circuit with said anode and said cathode, a dual heat source for said cathode including a first heat source providing initial partial heating of said filament and a second source energizing said filament through said contact means and providing a time delay before heating of said filament sufficient to cause effective conduction of said thermionic tube to energize said output means.

3. In a radio circuit for use with a signal voltage, the provision of a thermal time delay circuit including contact means actuated in accordance with said signal voltage, a thermionic tube having an anode and a cathode including a filament, a filament voltage source and a second voltage source, output means connected in circuit with said anode and said cathode, means connecting at least part of said filament to said filament voltage source to energize said part at a value insufficient to raise said cathode to normal electron emission, and means connecting at least part of said filament through said contact means to said second voltage source, whereby, when said contact means are periodically actuated at said signal voltage frequency, said cathode after a time delay is raised to substantially normal emission to cause conduction of said thermionic tube.

4. In a radio circuit for use with a signal voltage, the provision of a thermal time delay circuit including contact means actuated in accordance with said signal voltage, a thermionic tube having an anode and a cathode including a filament, a pilot relay having a winding, a filament voltage source and a second voltage source, circuit means connecting said pilot relay winding in circuit with said anode and said cathode, means connecting at least part of said filament to said filament voltage source to energize said part at a value insufficient to cause pull in of said pilot relay, and means connecting at least part of said filament through said contact means to said second voltage source, whereby, when said contact means are actuated at said signal voltage frequency, said filament after a time delay is energized to a value sufficient to cause conduction of said thermionic tube and pull in of said pilot relay.

5. In a receiver circuit for use with a carrier wave having a lower frequency intelligence thereon and subject to spurious interference energy, and demodulator means within said receiver circuit to obtain said lower frequency output, the provision of a thermal time delay circuit in-

cluding a thermionic tube having an anode and a cathode including a filament, a pilot relay having a winding, a filament voltage source, circuit means connecting said pilot relay winding in circuit with said anode and said cathode, means connecting at least part of said filament to said filament voltage source to energize said part at a value insufficient to cause pull in of said pilot relay, and means connecting at least part of said filament to be energized in accordance with said lower frequency output of said demodulator, whereby, when said demodulator has said lower frequency output, said filament after a time delay is energized to a value sufficient to cause conduction of said thermionic tube and pull in of said pilot relay.

6. In a circuit for use with a carrier wave having a lower frequency intelligence thereon and subject to spurious interference, the provision of a thermal time delay circuit including contact means, means to actuate said contact means at said lower frequency rate and adapted to be actuated by energy from any said spurious interference, a thermionic tube having an anode and a cathode including a filament, a filament voltage source and a second voltage source, output means connected in circuit with said anode and said cathode, means connecting at least part of said filament to said filament voltage source to energize said filament at a value insufficient to raise said cathode to normal electron emission, and means connecting at least part of said filament through said contact means to said second voltage source, whereby, when said contact means are periodically actuated at said lower frequency, said cathode after a time delay is raised to substantially normal emission to cause conduction of said thermionic tube.

7. In a receiver circuit for receiving a carrier wave having a lower frequency intelligence thereon and subject to receiving energy from lightning flashes within the frequency of the said carrier wave, and demodulator means within said receiver circuit to obtain said lower frequency output, the provision of a thermal time delay circuit including contact means actuated by said demodulator means at said lower frequency rate and adapted to be actuated by energy from any said lightning flashes, a thermionic tube having an anode and a cathode including a filament, a pilot relay having a winding, a voltage source, circuit means connecting said pilot relay winding in circuit with said anode and said cathode, and means connecting said filament through said demodulator contact means to said voltage source, whereby, when said demodulator contact means are periodically actuated at said lower frequency, said voltage source energizes said filament after a time delay to a value of energization to cause conduction of said thermionic tube and pull in of said pilot relay.

8. In a receiver circuit for receiving a carrier wave having a lower frequency intelligence thereon and subject to receiving energy from lightning flashes within the frequency of the said carrier wave, and demodulator means within said receiver circuit to obtain said lower frequency output, the provision of a thermal time delay circuit including contact means actuated by said demodulator means at said lower frequency rate and adapted to be actuated by energy from any said lightning flashes, a thermionic tube having an anode and a cathode including a filament, a pilot erlay having a winding, a filament voltage source and a second voltage source, circuit means connecting said pilot relay winding in circuit with said anode and said cathode, means connecting at least part of said filament to said filament voltage source to energize said part at a value insufficient to cause pull in of said pilot relay, and means connecting at least part of said filament through said demodulator contact means to said second voltage source, whereby, when said demodulator contact means are periodically actuated at said lower frequency, said filament after a time delay is energized

to a value sufficient to cause conduction of said thermionic tube and pull in of said pilot relay.

9. In a receiver circuit for receiving a carrier wave having a lower frequency intelligence thereon and subject to receiving energy from lightning flashes within the frequency of the said carrier wave, and demodulator means within said receiver circuit to obtain said lower frequency output, the provision of a thermal time delay circuit including contact means actuated by said demodulator means at said lower frequency rate and adapted to be actuated by energy from any said lightning flashes, a thermionic tube having an anode and a cahode including a filament, a pilot relay having a winding, a filament voltage source and a second voltage source, circuit means connecting said pilot relay winding in circuit with said anode and said cathode, means connecting said filament to said filament voltage source to energize said filament at a value insufficient to cause pull in of said pilot relay, and means connecting said filament through said demodulator contact means to said second voltage source, whereby, when said demodulator contact means are periodically actuated at said lower frequency, said second voltage source energizes said filament after a time delay to a value of energization to cause conduction of said thermionic tube and pull in of said pilot relay.

10. In a receiver circuit for receiving a carrier wave having a lower frequency intelligence thereon and subject to receiving energy from lightning flashes within the frequency of the said carrier wave, and demodulator means within said receiver circuit to obtain said lower frequency output, the provision of a thermal time delay circuit including contact means actuated by said demodulator means at said lower frequency rate and adapted to be actuated by energy from any said lightning flashes, a thermionic tube having a filament and an anode, a pilot relay having a winding, a filament voltage source, a second voltage source, means connecting said pilot relay winding between said anode and said second voltage source, means connecting said filament to said filament voltage source to energize said filament at a value insufficient to cause conduction of said thermionic tube, and means connecting said filament through said demodulator contact means to said second voltage source, whereby, when said demodulator contact means are periodically actuated at said lower frequency, said second voltage source energizes said filament to approximately full energization after a time delay to cause conduction of said thermionic tube and pull in of said pilot relay.

11. In a receiver circuit for receiving a carrier wave having a lower frequency intelligence thereon and subject to receiving energy from lightning flashes within the frequency of the said carrier wave, and demodulator means within said receiver circuit to obtain said lower frequency output, the provision of a thermal time delay circuit including contact means actuated by said demodulator means at said lower frequency rate and adapted to be actuated by energy from any said lightning flashes, a thermionic tube having a filament and an anode, a pilot relay having a winding, a direct current supply source, means connecting said pilot relay winding between said anode and said direct current supply source, an alternating current filament supply voltage, means connecting said filament of said filament supply voltage to energize said filament at a value insufficient to cause conduction of said thermionic tube, and means connecting said filament through said demodulator contact means to said direct current supply source, whereby, when said demodulator contact means are periodically actuated at said lower frequency, said direct current supply source energizes said filament to approximately full energization after a time delay to cause conduction of said thermionic tube and pull in of said pilot relay.

12. In a receiver circuit for receiving a carrier wave having a lower frequency intelligence thereon and subject to receiving energy from lightning flashes within the

frequency of the said carrier wave, and demodulator means within said receiver circuit to obtain said lower frequency output, the provision of a thermal time delay circuit including contact means actuated by said demodulator means at said lower frequency rate and adapted to be actuated by energy from any said lightning flashes, a thermionic tube having a filamentary cathode and having an anode, a pilot relay having a winding, a direct current supply source, means connecting said pilot relay winding between said anode and said direct current supply source, one end of said filamentary cathode being connected to ground, an alternating current filament supply voltage, means connecting the other end of said filamentary cathode to said filament supply voltage to energize said filamentary cathode at a value insufficient to cause conduction of said thermionic tube, and a voltage dropping resistor connecting said other end of said filamentary cathode through said demodulator contact means to said direct current supply source, whereby, when said demodulator contact means are periodically actuated at said lower frequency, said direct current supply source energizes said filamentary cathode to approximately full energization after a time delay to cause conduction of said thermionic tube and pull in of said pilot relay.

13. In a receiver circuit for receiving an interrupted carrier wave and subject to receiving energy from lightning flashes within the frequency of the said carrier wave, demodulator means within said receiver circuit to obtain a sub-audio frequency output at the interruption rate, and contact means in said demodulator means actuated at said interruption rate and adapted to be actuated by energy from any said lightning flashes, a thermal time delay circuit including, the provision of a thermionic tube having a filamentary cathode and having an anode, a pilot relay having a winding, a direct current supply source, means connecting said pilot relay winding between said anode and said direct current supply source, one end of said filamentary cathode being connected to ground, an alternating current filament supply voltage, means connecting the other end of said filamentary cathode to said filament supply voltage to energize said filamentary cathode at approximately half rated current but insufficient to cause conduction of said thermionic tube, and a voltage dropping resistor connecting said other end of said filamentary cathode through said demodulator contact means to said direct current supply source, whereby, when said demodulator contact means are periodically actuated at said interruption frequency, said direct current supply source energizes said filamentary cathode to approximately full energization after a time delay to cause conduction of said thermionic tube and pull in of said pilot relay.

14. A thermal time delay circuit including a radio receiver circuit for receiving an interrupted carrier wave and subject to receiving energy from lightning flashes in the frequency of the said carrier wave, demodulator means within said receiver circuit to obtain a sub-audio frequency output at the interruption rate, contact means in said demodulator means actuated at said interruption rate and adapted to be actuated by energy from any said lightning flashes, a thermionic tube having a filamentary cathode and having an anode, a pilot relay having a winding, a direct current supply source, a current limiting resistor connecting said pilot relay winding between said anode and said direct current supply source, one end of said filamentary cathode being connected to ground, an alternating current filament supply voltage, a current dropping resistor connecting the other end of said filamentary cathode to said filament supply voltage to energize said filamentary cathode at approximately half rated current but insufficient to cause conduction of said thermionic tube, and a voltage dropping resistor connecting said other end of said filamentary cathode through said demodulator contact means to said direct current supply source, whereby, when said demodulator contact means are periodically actuated at said interruption frequency said direct current supply source energizes said filamentary cathode to approximately full energization after a time delay in the order of one-fourth to one second to cause conduction of said thermionic tube and pull in of said pilot relay.

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