

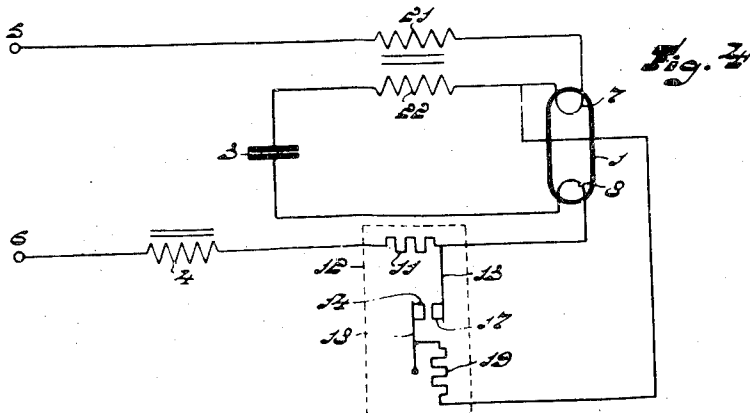
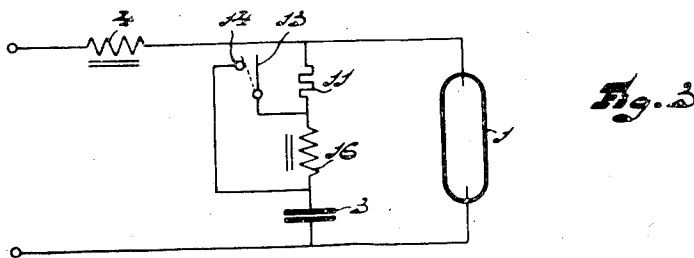
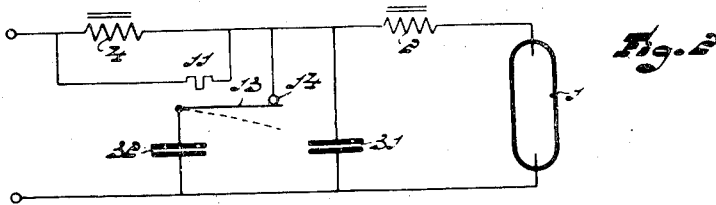
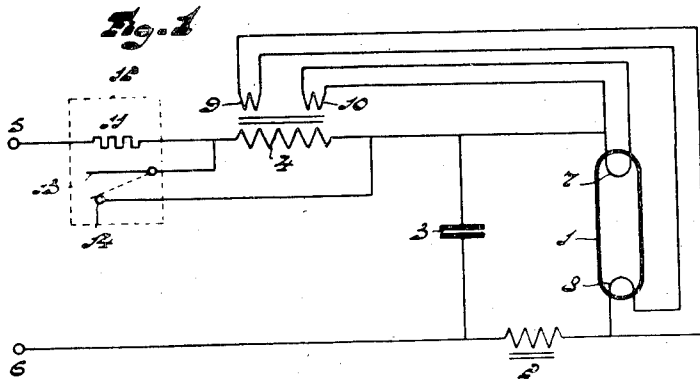
Aug. 23, 1949.

F. C. VAN LOOY ET AL

2,480,060

DEVICE COMPRISING A GASEOUS DISCHARGE TUBE

Filed March 11, 1947.



INVENTOR
F. C. VAN LOOY
P. SCHOUWSTRA
BY *Her M. Vogel*
AGENT

UNITED STATES PATENT OFFICE

2,480,060

DEVICE COMPRISING A GASEOUS
DISCHARGE TUBE

Franciscus Cornelis van Looy and Pieter Schouwstra, Eindhoven, Netherlands, assignors to Hartford National Bank and Trust Company, Hartford, Conn., as trustee

Application March 11, 1947, Serial No. 733,750
In the Netherlands March 18, 1942

Section 1, Public Law 690, August 8, 1946
Patent expires March 18, 1962

10 Claims. (Cl. 315-243)

1

It is known to ignite gaseous discharge tubes with the aid of a resonant circuit which, prior to the ignition of the gaseous discharge tube, is traversed by a strong current which generates in the elements of the circuit high voltages which may be used to ignite the gaseous discharge tube. After the ignition of this tube the current strength falls considerably at least in a part of this circuit, since the discharge tube which is then conductive is connected in parallel with a part of the resonant circuit which consequently gets out of resonance. The elements of the circuit are as a rule proportioned in accordance with the current strength which occurs, i. e. during the normal operation of the discharge tube.

In the case, however, that the discharge tube does not ignite after the device has been put under tension, the strong resonant current keeps flowing, which not only implies an unnecessary waste of energy but also an overcharge of the elements of the circuit, due to which these elements might be deteriorated.

A device is known which comprises a gaseous discharge tube having one incandescent cathode and two anodes, which tube is fed by an autoleakage transformer, one extremity of the secondary winding of this transformer being connected to one terminal of a condenser, whereas the other extremity of this winding is connected to a choke-coil; the other terminal of the condenser is connected to a tapping of the choke-coil, so that this condenser and a part of the choke-coil in series with one another are connected to the extremities of the secondary transformer winding. The circuit thus produced constitutes a resonant circuit. One of the anodes of the gaseous discharge tube is directly connected to that extremity of the transformer which is connected to the condenser, whereas the other anode is connected to that extremity of the choke-coil which is remote from the transformer through the intermediary of an interruptor and the heating elements of two thermal switches. The cathode of the gaseous discharge tube is connected to the middle of the secondary winding of the transformer.

When this device is put under tension, a high voltage is set up between the two anodes of the gaseous discharge tube by means of the resonant circuit, said voltage bringing about an auxiliary discharge between the anodes. The intensity of this discharge is initially small, since the auxiliary discharge path has connected in series with it the two heating elements of the said switches, one of which has a high resistance. Consequently, the

2

occurrence of the main discharge is also retarded, which enables the incandescent cathode, which is heated from the outside, to attain its emission temperature. The current of the auxiliary discharge is sufficiently high to close the thermal switch whose heating element has a high resistance, due to which this heating element is short-circuited. If the discharge tube is not defective, the main discharge can subsequently be ignited.

If this main discharge does not ignite, however, the current of the auxiliary discharge, which current has acquired a much greater strength due to the described short-circuit of the heating element, brings about a strong development of heat in the second heating body. Consequently, after a certain lapse of time, the contact of the bimetallic element heated by this heating body contacts with the countercontact, due to which the condenser of the resonant circuit is bridged by a part of the choke-coil and the two heating elements of the thermal switches. Consequently, the resonant circuit is brought out of resonance and an overcharge of the device is avoided.

In order to prevent the condenser from being shunted also when the main discharge is ignited, the device comprises, in addition, auxiliary means which make the thermal switches inoperative under the action of the main discharge current. These auxiliary means are constituted by the interruptor already referred to, which is constructed in the form of an electromagnetic switch. On being energised by the main discharge current, said interruptor switches off the heating elements of the thermal switches, establishing at the same time a direct connection between the last-mentioned anode and that extremity of the secondary winding of the transformer which is connected to the choke-coil.

The condenser is bridged and hence the resonant circuit is brought out of resonance in this known device by the current of the auxiliary discharge between the two anodes of the discharge tube. If this auxiliary discharge is not established (which may be due, for example, to a bad contact or to a crack in the supply conductor or to the circumstance that it has been omitted to place the discharge tube in the device), the resonant state and the drawbacks involved subsist, however, after the device has been switched in. Moreover, this known device which utilises thermal switches and, in addition, auxiliary means to render these switches inoperative under the action of the discharge current, is very complicated.

The present invention relates to a device comprising a gaseous discharge tube which, if neces-

sary with the interposition of an impedance, bridges a part of a resonant circuit comprising a series-connected inductance and a capacity. The term "resonant circuit" is to be understood to mean not only a circuit whose capacitive impedance is exactly equal to the inductive impedance, since these impedances will as a rule be different from each other. It is only necessary that the circuit is so tuned to the frequency of the feeding current that in that portion of the circuit which is shunted by the discharge tube a voltage is generated which is sufficiently high for a normal ignition of the gaseous discharge tube. The term "gaseous discharge tube" has to be understood to mean not only a discharge tube filled with one or more gases, but also a tube in which the discharge takes place in an atmosphere consisting of vapour or a mixture of gas and vapour.

The present invention has for its purpose to realise the known principle, according to which a too long continuation of a too strong current in the resonant circuit in the case of non-ignition of the discharge tube is avoided, in a better and simpler manner than is known hitherto.

According to the invention, the circuit is brought out of resonance with the aid of a time-lag switch whose energising element either is located in the resonant circuit, or is connected in parallel with a part of the resonant circuit, said switch being constructed in such manner that the current which has to flow through the energising element to actuate the switch is higher than that which flows during normal operation of the discharge tube, but at most equal to the current which flows through this element when the tube is not ignited, while the switch, once become operative, keeps the position then occupied until the device is made voltageless.

When the device is switched-in while the discharge tube is defective, so that it cannot ignite, the state of resonance continues only during the time-lag of the switch; after expiration of this time-lag the switch, due to the latter being closed or opened, brings the circuit out of resonance so that the current strength is reduced to a value which is not injurious to the elements constituting the circuit. If the switch were constructed in such manner that it would return to its initial position with this smaller current strength, the state of resonance and the undesirable strong current involved in the case of non-ignition of the discharge tube would be re-established. This drawback is obviated due to the switch being so constructed that, once become operative (i. e. after it has been closed or opened), it keeps its position then occupied until the device is made voltageless. When a new discharge tube is substituted for the defective one, the device is then immediately ready again for its normal function.

Since the switch is actuated by the resonant current itself (or, if the energising element of the switch is connected in parallel with a part of the resonant circuit, by a current proportional to the resonant current) it will perform its function not only when the discharge tube does not ignite due to a cause which resides in the tube itself, but for example also when the tube is not present in the device or there is a crack or a bad contact in the supply conductors of the tube.

When the device is switched-in whilst the discharge tube is capable to ignite, the state of resonance due to the time-lag of the switch continues for a sufficiently long time to ignite the discharge tube. If the ignition is effected in

time, the energising element of the switch is then traversed only by a current which cannot actuate the switch. Particular auxiliary means which make the switch inoperative under the action of the discharge current flowing through the discharge tube are here consequently superfluous, which renders the device also simpler than the known device above-described.

The resonant circuit may be brought out of resonance in different manners. The switch may bridge or switch off, for example, a portion of the resonant circuit or add an impedance to the resonant circuit. The bridging may be effected by means of an auxiliary circuit which is also connected in parallel with the discharge tube. When the discharge tube ignites, the discharge path which has then become conductive brings the resonant circuit out of resonance, whereas, if the discharge tube does not ignite, this is effected by means of the auxiliary circuit which is connected in parallel with the discharge tube.

In addition to the resonant current, the device may also be traversed under certain conditions by other currents of impermissible strength and duration. The initially equal emissive power of the electrodes may, for example, have changed by the end of the life of the tube in such manner that the current in a definite half-cycle of the feeding alternating current is considerably smaller than in the following half-cycle. This implies the occurrence of a direct-current component with the result that a choke-coil which is connected in series with the tube has a smaller impedance and consequently passes a stronger current than when an alternating current without direct-current component flows. In this case the choke-coil and also other elements of the device are subject to a stronger heating than in normal operation.

According to one embodiment of the invention, in this case also any deterioration of the elements of the device may be prevented by connecting the energising element of the switch, at least during the normal operation, in series with the discharge tube. It is thus achieved that the switch is actuated not only when the tube does not ignite but also when a direct-current component of impermissible strength occurs.

If it is desired with the aid of the precautions taken in accordance with the invention to protect the device also against such undesirable current strengths which occur after the ignition of the discharge tube, it is possible by a suitable choice of the construction of the switch to determine the current strength which is still permissible. In this case the switch will be, for example, such that the minimum current which has to flow through the energising element to actuate the switch is at the utmost 50% or 30% higher than the current which flows through the energising element of the switch in normal operation of the discharge tube.

In some embodiments of the invention it may occur that, after the switch has been actuated, the current flowing through the energising element of the switch is too small to keep the switch in the position then occupied. Consequently, the position of too high current strength would be re-established, whereupon the switch would be actuated again, which would continuously be repeated. This drawback may be obviated by providing the switch with an auxiliary energising element which is not traversed by current until the switch has been actuated by the main

5

energising element. To this end, said auxiliary energising element may be included, for example, in the auxiliary circuit which as a result of the actuation of the switch is connected in parallel with a part of the resonant circuit. When use is made of a bimetallic switch, each of the two contacts may be secured, for example, to a bimetallic strip which comprises a heating element. In this case one heating element is included in the resonant circuit, whereas the second heating element is included in an auxiliary circuit which may bridge the discharge tube.

The invention will be explained more fully by reference to the accompanying drawing showing diagrammatically, by way of example, several embodiments thereof and in which

Figure 1 illustrates one form of circuit arrangement in accordance with the invention,

Figure 2 illustrates another circuit arrangement in accordance with the invention,

Figure 3 illustrates a further modification in accordance with the invention and

Figure 4 illustrates still another embodiment of the invention.

In Fig. 1, 1 designates a discharge tube filled with gas and vapour, for example a low-pressure mercury vapour discharge tube, whose wall may be covered with substances which become luminescent under the action of the mercury vapour discharge. This tube bridges a condenser 3 with the interposition of a choke-coil 2, said condenser being connected to a source of alternating current of normal frequency via a choke-coil 4 and terminals 5 and 6. The voltage of this source of current is lower than the ignition voltage of the tube. The choke-coil 4 and the condenser 3 have such values that a voltage is set up at the terminals of the condenser, which is higher than the voltage of the source of supply and sufficiently high to ignite the tube. The discharge tube may contain either cold or incandescent electrodes. According to Fig. 1, tube 1 contains two incandescent electrodes 7 and 8 which are fed from two heating windings 9 and 10 of a transformer, the primary winding of which is constituted by the choke-coil 4.

The circuit constituted by the series connection of the choke-coil 4 and the condenser 3, after the terminals 5 and 6 of the device have been connected to the source of alternating current, is traversed by a strong current which serves for a quick heating of the incandescent electrodes via the heating windings 9 and 10 and which also ignites the tube. After the ignition of the tube, the high current flowing through said circuit falls considerably, though the current which flows through the choke-coil 4 does not become the same as the current which flows through the condenser 3.

The heating element 11 of a bimetallic switch 12 is connected in series with the circuit 4-3 and the discharge tube 1. The bimetallic element 13 and the contact piece 14 of this switch are connected to the extremities of the choke-coil 4, so that the switch short-circuits the latter in the position of the bimetallic element 13 which is indicated in dotted line. The bimetallic switch is such that it keeps open with the current strength which occurs when the tube is ignited and that its contacts engage each other with a current strength which is higher than the current which flows when the tube is ignited and smaller than the current which flows when the tube does not ignite. At the same time it is ensured that the current which flows through the

6

heating element 11 when the choke coil 4 is short-circuited keeps the contacts of the switch closed.

In a concrete case the bimetallic switch enclosed in an evacuated little tube was so constructed that its contacts closed with any current higher than 195 milliamps. and in the hot condition of the switch kept closed with currents higher than 180 milliamps. The contacts are closed more quickly, according as the current is higher than the said value. Prior to the ignition, which in the normal condition of tube 1 takes place within one second, and with a terminal voltage of 220 volts of the source of supply of 50 cycles/sec. the heating element 11, the choke-coil 4 and the condenser 3 were traversed by a current of 510 milliamps. With this current strength the bimetallic switch has a closing time of 18 seconds, so that the switch was not actuated during the period of ignition of the tube. During this period the voltage set up at the terminals of the condenser 3 and also at the electrodes of the tube was 390 volts, whereas a voltage of 190 volts was set up at the choke-coil 4. After the ignition, i. e. in less than 1 sec., the current flowing through the choke-coil 4 decreased to 145 milliamps., the current flowing through the condenser 3 to 320 milliamps., the voltage set up at the choke-coil 4 to 78 volts and the voltage set up at the condenser 3 to 240 volts, while the current flowing through the tube 1 and the choke-coil 2 now attained 250 milliamps. and the voltage of the tube 105 volts.

When the tube does not ignite, the above stated high currents and voltages subsisted for 18 seconds, until the bimetallic switch short-circuited the choke-coil 4. Subsequently, the current flowing through the heating element 11 and through the condenser 3 decreased to 285 milliamps. and the voltage set up at the condenser 3 to about 220 volts. Since this current strength is higher than the minimum current strength required to maintain the switch closed, this condition of decreased current subsisted. After the device had been switched off and the defective tube replaced, the bimetallic switch was cooled down, so that the device was again in its original condition as soon as it was switched-in anew.

The circuit described offers the additional advantage that a too high current strength brought about by other causes may also be decreased. This case may occur when the tube takes up currents of different values in successive half-cycles due to the emissive power of the incandescent electrodes having become different. This phenomenon implies the occurrence of a direct-current component which premagnetises the iron cores of the choke-coils 2 and 4 and brings about higher iron losses, higher operating temperatures and a lower value of the inductance of the choke-coils, as well as a stronger current through the whole device.

If the current strength in the heating element 11 exceeds a value of 195 milliamps., the bimetallic switch short-circuits the choke-coil 4 with a definite time-lag. After this short-circuiting the tube may extinguish, which corresponds to the state of the not igniting tube and the short-circuited choke-coil 4. Consequently, this short-circuit also subsists and the device is automatically ready for use again after it has been switched off and the tube changed. It is, however, also possible after the choke-coil 4 has been short-circuited that the tube keeps burning at the voltage of 220 volts of the source of supply. In this case the heating element 11 is traversed

by a current of 235 milliamps., so that this condition subsists with a current through the tube of 135 milliamps. The tube is now burning at approximately half the current, gives little light and consequently attracts the notice. In this case also the device is ready for further operation after suppression of the disturbance.

It is evident that it is not necessary for the bimetallic switch to short-circuit the choke-coil, since the latter may also be bridged by it via a resistance.

Fig. 2 shows a device which differs from that shown in Fig. 1 in so far as the heating element is connected in parallel with the choke-coil 4 and the capacity 3 is constituted by the parallel connection of two condensers 31 and 32, of which condenser 32 is switched off when tube 1 does not ignite. The contacts of the bimetallic switch are then opened by the high current. The operation of this device corresponds to that of the device shown in Fig. 1.

It is evident that the increased current strength due to a rectifying action of the tube may here also be reduced to a harmless value. In Fig. 2, the incandescent electrodes and their circuits are omitted for simplicity's sake. Identical elements are indicated in the figures by the same numerals.

Fig. 3 shows a device in which the resonant circuit is constituted by the series-connection of the choke-coils 4 and 16 and the condenser 3. Tube 1 bridges the choke-coil 16 and the condenser 3. Any available incandescent electrodes of the tube may be supplied from a transformer, the primary winding of which is constituted by the choke-coil 16. In this device the current which flows through the choke coil 4 before and after the ignition of the tube does not change appreciably, so that a limitation of this current if the tube does not ignite is superfluous. However, the current which flows through the part 16-3 of the circuit, which is bridged by the tube, changes considerably.

By including the heating element 11 of a bimetallic switch in that part of the circuit which is bridged by the tube and by connecting the bimetallic element 13 and the contact piece 14 of the bimetallic switch to the extremities of the choke-coil 16, it may be achieved that the current which flows through the parallel branch when the tube is not ignited is decreased to a permissible value. As it appears already from the devices before described, it must then be ensured that, after the choke-coil 16 has been short-circuited, a current flows which is sufficiently high to maintain the contacts of the switch in closed position.

In a concrete case the current which flowed through the choke-coil 4 prior to the ignition of the tube was 126 milliamps. and the current which flowed through the heating element 11, the choke-coil 16 and the condenser 3 : 226 milliamps. After the ignition these currents were 225 milliamps. and 56 milliamps. respectively. After the choke-coil 16 has been short-circuited, the current which flowed through the elements 4, 11 and 3 was 123 milliamps. The bimetallic switch was so constructed that its contacts were kept closed with security with currents higher than 80 milliamps.

It is evident that the switch, instead of short-circuiting the choke-coil 16, may alternatively bridge the latter or a part thereof via an impedance. In addition, this switch may bridge the condenser 3 with or without the interposition of impedances, switch off a part of the capacity of

this condenser and/or connect a condenser in parallel with the condenser 3 or with one or more elements of the device.

Fig. 4 shows a device which differs from that shown in Fig. 1 in that the incandescent electrodes are connected in series with the auxiliary elements of the circuit. For this purpose the incandescent electrode 8 is included between the condenser 3 and the choke-coil 4, the choke-coil 2 of Fig. 1 comprising two windings 21 and 22 which are arranged on the same iron core, which have approximately the same number of turns and which are connected to each other via the incandescent electrode 7 in such manner that the series current flowing through these windings prior to the ignition of the tube 1 generates magnetic fields which counteract each other so as to practically neutralise each other. During the normal operation, however, this choke-coil operates in substantially the same manner as the choke-coil 2 in the circuit of Fig. 1.

In series with the circuit comprising all the circuit elements of the device and in series with the tube is included a heating element 11 of a bimetallic switch 12, for example the connection between the choke-coil 4 and the electrode 8 as is shown in the figure. The switch 12 comprises two bimetallic strips 13 and 18. The fixed extremity of the bimetallic strip 13 is connected to a point between the heating element 11, which cooperates with this strip, and the electrode 8, whereas the movable extremity comprises a contact piece 17. The other bimetallic strip 18 comprises as its movable extremity a countercontact piece 14 and is connected through a separate heating element 19 to a point located between the electrode 7 and the winding 22.

This device operates as follows:

When the device is connected to the source of alternating current, a strong current which is substantially determined by the choice of the capacity of the condenser 3 and the inductance of the choke-coil 4 flows through the series circuit 21-7-22-3-8-11-4. This current heats the electrodes 7 and 8 and brings about a potential difference across the condenser 3, which is also set up substantially unchanged at the tube 1 and ignites the latter. After the ignition of the tube, the high current flowing through the said circuit falls considerably; in this case the currents flowing through the windings 21, 22 and through the discharge tube 1 are relatively different.

If the tube does not ignite, the heating element 11 heats the strip 13 so strongly that the contact piece 17 engages the countercontact 14, thus establishing a direct connection between the electrodes via the other heating element 19, due to which the undesirable high current through the heating element 11 is considerably reduced. Consequently, the strip 13 is heated less strongly so that it would be withdrawn again from the contact piece 14. The heating element 19 is, however, so proportioned as to cause the strip 18 and the contact piece 14 in the direction of the contact piece 17 to withdraw more quickly than the strip 13 and the contact piece 17 retire, so that the contact between the contact pieces 17 and 14 subsists until the device is switched off from the source of supply.

This device also permits of reducing an undesirable high current resulting from the occurrence of a direct-current component.

The two bimetallic strips 13 and 18, together with their heating elements 11 and 19, may be so proportioned as to be equal to each other.

In a concrete case the elements of the device were so chosen that, when the tube does not ignite or does not yet ignite, a current of about 450 milliamps. flowed through the heating element 11. During the normal operation of the tube this current was 150 milliamps. and could assume a strength of from 250 to 400 milliamps. when a direct-current component occurred. When the contact pieces 14 and 17 engaged each other, the current through the heating element 11 was about 140 milliamps. whereas the heating element 19 was then traversed by a current of 330 milliamps.

The two bimetallic strips 13 and 18 and their heating elements 11 and 19 were equally proportioned and exhibited the following characteristic: closure at 450 milliamps. within 20 seconds, with 250 milliamps. within 120 seconds, no closure with 185 milliamps. or less.

If the tube after being switched-in does not ignite within 20 seconds, or a direct-current component greater than 185 milliamps. occurs, the contacts 14 and 17 are closed. This contact keeps closed until the device is switched off, since the condition that the strip 18 with 330 milliamps. is heated up by the element 19 more quickly than the strip 13 cools down with a sudden fall of the current through the element 11 to 140 milliamps, is largely satisfied.

Whenever in the explanation of the devices shown in the figures reference is made to bimetallic switches, it is possible for the purpose of bringing about the desired changes to utilise, instead of these elements, other known means operating with the required time-lag, for example electro-magnetic switches.

What we claim is:

1. An alternating current electrical circuit arrangement comprising capacitive and inductive elements coupled in series arrangement and having reactance values to produce a resonance circuit, a gaseous electric discharge tube coupled in shunting relationship with one of said elements, and a time delay switch comprising an actuating member and switch contact members, said switch contact members being coupled to one of said elements to vary the reactance value thereof in said series circuit while maintaining said series circuit continuous, and said actuating member being coupled to said series circuit and being responsive to resonance current flow in said series circuit to actuate said switch contact members and being further responsive to non-resonance current flow in said series circuit to maintain said switch contact members in actuated position.

2. An alternating current electrical circuit arrangement comprising capacitive and inductive elements coupled in series arrangement and having reactance values to produce a resonance circuit, a gaseous electric discharge tube coupled in shunting relationship with one of said elements, and a time delay switch comprising an actuating member and switch contact members, said switch contact members being coupled to one of said elements to vary the reactance value thereof in said series circuit while maintaining said series circuit continuous, and said actuating member being connected in series with said series circuit and being responsive to resonance current flow in said series circuit to actuate said switch contact members and being further responsive to non-resonance current flow in said series cir-

cuit to maintain said switch contact members in actuated position.

3. An alternating current electrical circuit arrangement comprising capacitive and inductive elements coupled in series arrangement and having reactance values to produce a resonance circuit, a gaseous electric discharge tube coupled in shunting relationship with one of said elements, and a time delay switch comprising an actuating member and switch contact members, said switch contact members being coupled to one of said elements to vary the reactance value thereof in said series circuit while maintaining said series circuit continuous, and said actuating member being connected in shunt with one of said elements and being responsive to resonance current flow in said series circuit to actuate said switch contact members and being further responsive to non-resonance current flow in said series circuit to maintain said switch contact members in actuated position.

4. An alternating current electrical circuit arrangement comprising capacitive and inductive elements coupled in series arrangement and having reactance values to produce a resonance circuit, a gaseous electric discharge tube coupled in shunting relationship with one of said elements, and a time delay switch comprising an actuating member and switch contact members, said switch contact members bridging one of said elements to vary the reactance value thereof in said series circuit, and said actuating member being coupled to said series circuit and being responsive to resonance current flow in said series circuit to actuate said switch contact members and being further responsive to non-resonance current flow in said series circuit to maintain said switch contact members in actuated position.

5. An alternating current electrical circuit arrangement comprising capacitive and inductive elements coupled in series arrangement and having reactance values to produce a resonance circuit, one of said elements comprising a first and a second component, a gaseous electric discharge tube coupled in shunting relationship with one of said elements, and a time delay switch comprising an actuating member and switch contact members, said switch contact members being coupled to one of said elements to disconnect one of said components and thereby vary the reactance value of said element in said series circuit while maintaining said series circuit continuous, and said actuating member being coupled to said series circuit and being responsive to resonance current flow in said series circuit to actuate said switch contact members and being further responsive to non-resonance current flow in said series circuit to maintain said switch contact members in actuated position.

6. An alternating current electrical circuit arrangement comprising capacitive and inductive elements coupled in series arrangement and having reactance values to produce a resonance circuit, a gaseous electric discharge tube coupled in shunting relationship with one of said elements, and a time delay switch comprising an actuating member and switch contact members, said switch contact members bridging one of said elements to vary the reactance value thereof in said series circuit, and said actuating member being connected in series with said series circuit and being responsive to resonance current flow in said series circuit to actuate said switch con-

tact members and being further responsive to non-responsive current flow in said series circuit to maintain said switch contact members in actuated position.

7. An alternating current electrical circuit arrangement comprising a capacitive element, a first inductive element comprising a first winding connected in series circuit with said capacitive element and second and third windings inductively coupled to said first winding, said capacitive and inductive elements having reactance values to produce a resonance circuit, a gaseous electric discharge tube comprising two filamentary electrodes and having one electrode thereof connected to one terminal of said capacitive element, a second inductive element interconnecting the other electrode of said tube and the other terminal of said capacitive element, means to couple said electrodes to said second and third windings, and a time delay switch comprising an actuating member and switch contact members, said switch contact members bridging said first winding, and said actuating member being connected in series with said first winding and said capacitive element and being responsive to resonance current flow in said series circuit to actuate said switch contact members to a closed position and being further responsive to non-resonance current flow through said capacitive element to maintain said switch contact members in closed position.

8. An alternating current electrical circuit arrangement comprising a capacitive element having a first component and a second component, a first inductive element connected in series circuit with said capacitive element, said capacitive and inductive elements having reactance values to produce a resonance circuit, a gaseous electric discharge tube comprising two electrodes and having one electrode thereof connected to one terminal of said capacitive element, a second inductive element interconnecting the other electrode of said tube and the other terminal of said capacitive element, and a time delay switch comprising an actuating member and switch contact members, said switch contact members being connected in series with one of said capacitive element components, and said actuating member being connected in shunt with said first inductive element and being responsive to resonance current flow in said series circuit to actuate said contact members to an open position and being further responsive to non-resonance current flow through said series circuit to maintain said contact members in open position.

9. An alternating current electrical circuit arrangement comprising in series circuit arrangement a capacitive element and an inductive ele-

ment having a first and second component, said capacitive and inductive elements having reactance values to produce a resonance circuit, a gaseous electric discharge tube connected in shunt with said capacitive element and one of said inductive element components, and a time delay switch having an actuating element and switch contact members, said switch contact members shunting said one inductive element component, and said actuating element being connected in series with said capacitive element and said one inductive element component and being responsive to resonance current flow in said series circuit to actuate said contact members to a closed position and being further responsive to non-resonance current flow through said series circuit to maintain said contact members in closed position.

10. An alternating current electrical circuit arrangement comprising a gaseous electric discharge tube having two filamentary electrodes, a series circuit comprising in the order named a first inductive element, one of said electrodes, a capacitive element, a second inductive element, the other of said electrodes and a third inductive element, said first inductive element and said capacitive element having reactive values to produce a resonance circuit, said second and third inductive elements being mutually coupled to produce magnetic fields which substantially counteract each other during resonance current flow in said series circuit, and a time delay switch comprising two contact members, a first actuating element for one of said contact members and a second actuating element for the other of said contact members, said contact members being connected in shunt with said tube, said first actuating element being connected in said series circuit and being responsive to resonance current flow to close said contact members and said second actuating element being connected in series with said contact members and being responsive to non-resonance current flow in said series circuit to maintain said contacts in closed position.

FRANCISCUS CORNELIS VAN LOOY.
PIETER SCHOUWSTRA.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,975,770	Culver	Oct. 9, 1934
2,170,457	Lord	Aug. 22, 1939
2,182,609	Bethenod	Dec. 5, 1939
2,291,355	Simmon	July 28, 1942
2,373,402	Lecorguillier	Apr. 10, 1945