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E. MEILI

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METHOD OF AND ARRANGEMENT FOR OPERATING A GLOW RELAY

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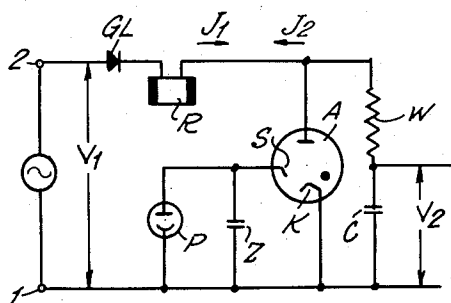


FIG. 1

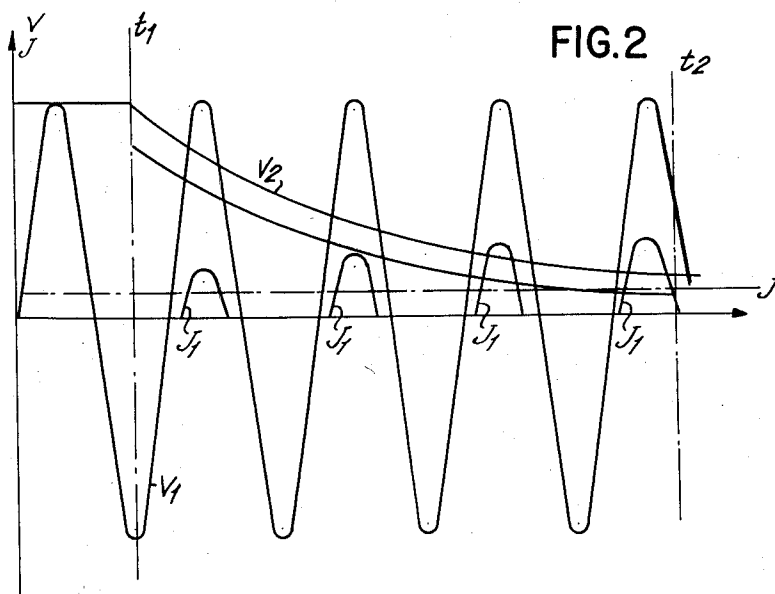


FIG. 2

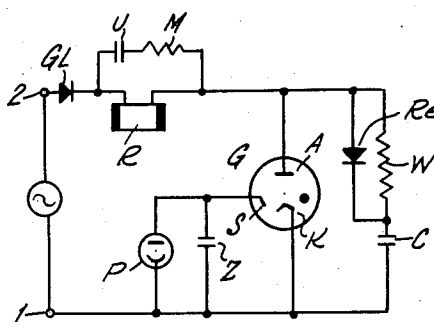


FIG. 3

INVENTOR.
ERNST MEILI

BY
Herbert M. Strauss, RGT.

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Ernst Meili, Kusnacht, Zurich, Switzerland, assignor to
Cerberus G.m.b.H., Bad-Ragaz, Switzerland, a company
of Switzerland

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The present invention relates to a method of delaying extinction of a glow relay tube supplied with an alternating voltage and more particularly to a circuit comprising a glow relay tube which remains glowing for at least a few periods of an alternating current supplied thereto.

The simplest design of a glow relay tube comprises a closed container filled with an inert gas into which at least two main electrodes are introduced. If a voltage between the ignition voltage and the sustained-glow potential of the main discharge gap formed by the said two electrodes is applied to such a tube, no current will normally pass through the tube. The tube will become conducting only after being ignited by additional measures. Such ignition may be effected by introducing a third electrode, the ignition electrode, into the tube and by initiating an igniting discharge e.g. between the ignition electrode and one of the main electrodes. Such a tube is known as a glow relay tube. One of the properties of such tubes is that a tube once ignited will generally not extinguish automatically while the main discharge gap is supplied with direct voltage. In order to break the current passing through the tube, the instantaneous value of the voltage supplied must briefly be reduced below the sustained-glow voltage of the discharge gap. In order to be able to ignite the tube again, the supply voltage must again be increased at least to the level of the sustained-glow potential; commonly a substantially higher voltage will be required.

In circuit designing it often occurs that a glow tube should ignite and then be extinguished again with the advent of a certain control voltage such as by supplying the glow tube with an alternating voltage or a pulsating direct voltage. With such an arrangement ignition must be effected when the voltage at the main electrodes possesses the required value (synchronization of ignition with supply voltage) while the tube will automatically extinguish as soon as the instantaneous value of the supply voltage drops below sustained-glow voltage. If the glow tube is to operate during each cycle, a synchronized control pulse must be received in each cycle or a continuous control discharge must be present in the tube.

If an electromechanical relay of suitable design is connected in series with a glow tube so operated, the relay will be energized as long as the tube is re-ignited in each cycle.

The problem becomes more difficult if the relay is required to remain energized when the tube is ignited not in each cycle but, for example, only in every second or third cycle. However, this problem may be solved in a similar manner if the relay has a sufficiently slow release. The delaying means useful therefor are: short-circuited winding or a condenser or rectifier connected in parallel with the relay, or a mechanical release retarder. Release retardation is in such cases caused by the electrical, magnetic or mechanical energy stored. The delay is proportional to the stored energy. This

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energy must be supplied during the ignition phase and the current flowing during that time must be of corresponding intensity.

Numerous circuit problems exist which cannot be solved with the arrangement described because it is impossible to obtain a sustained control discharge or such a sequence of control pulses that the glow tube is ignited at intervals sufficiently brief. If a very small direct current is available for control, such as supplied, by way of example, by a poorly lit photocell, the tube cannot be controlled direct by this weak current. Usually the problem is solved by employing this current to charge a small condenser connected in parallel with the control discharge gap. When the voltage in the condenser has reached ignition level, it will give an impulse discharge through the control discharge gap, whereby an ignition between the main electrodes occurs. It is understandable that the number of such impulse discharges per unit time will decrease with decreasing control current. With a direct current of, for example, 1μ volts and a condenser of 1000 pf., a discharge in the control circuit is obtained every .5 second. In such cases it is usually impossible owing to the limited capacitance of glow tubes to store enough energy in the relay circuit during an ignition period for the necessary delay time to be obtained.

It is therefore a primary object of the present invention to provide a circuit comprising a glow relay tube wherein the glow relay tube is controllable by a small energy source, for instance, a photoelectric cell.

It is another object of the present invention to provide a circuit comprising a glow relay tube supplied with an alternating voltage or a pulsating direct voltage in which the glow relay tube remains ignited during a time corresponding to at least a few periods of said alternating voltage or said pulsating direct voltage, respectively.

It is a further object of the invention to provide a circuit comprising a glow relay tube and a mechanical relay wherein said mechanical relay remains energized when a controlling device supplies a controlling current in the magnitude of only some 10^{-7} amperes.

Further, it is an object of the present invention to provide a circuit comprising a glow relay and a mechanical relay wherein said mechanical relay remains energized when said glow relay is receiving D.C. pulses of a frequency which may be substantially smaller than the frequency of the alternating voltage or the pulsating direct voltage supplied to said two relays.

It is still a further object of the present invention to provide a circuit having a glow relay tube which tube is supplied with alternating current, in which circuit the tube can be ignited at any moment irrespective of the phase position of the supplying alternating voltage.

According to one aspect of the invention, there is provided a mechanical relay and a glow relay tube in serial connection, said glow relay tube and said mechanical relay each being by-passed by an impedance and a capacitor in serial connection, said two relays being connected with a source of alternating voltage or pulsating direct voltage, so that the glow relay tube, when energized remains ignited until said capacitor connected in parallel thereto is discharged below a predetermined degree, while the mechanical relay is deenergized only when the glow relay tube is not ignited again within a predetermined time after it has been extinguished.

Other objects and features of the invention will become apparent from the following detailed description, reference being made to the accompanying drawings in which:

Fig. 1 is a wiring diagram of an embodiment of the invention;

Fig. 2 is a graph showing the voltages and currents of the circuit shown in Fig. 1 in dependency of time; and Fig. 3 is a wiring diagram of another embodiment of the invention.

In the wiring diagram of Fig. 1 showing the embodiment of the invention, G is a glow tube having two main electrodes A and K, and the igniting or control electrode S. Connected in series with the main gap defined by the main electrodes A and K is a mechanical relay R having an energizing and a short-circuited winding (not shown), the latter defining a storage means. An alternating voltage source is applied across the two input terminals 1 and 2. Connected with one terminal of the mechanical relay R is the rectifier G1 also connected to input terminal 2. The electrode K is connected to input terminal 1. Connected in parallel with the gap A—K are the series-connected condenser C and impedance W.

The control electrode S is connected to any controlling device which is supposed to control a large current, for example, a photoelectric cell, a thermoelement, a piezoelectric crystal or some other sensitive device. For illustration only, a photoelectric cell P is shown in Fig. 1. In parallel with the cell P is connected a condenser Z which is supposed to be charged by the voltage supplied by the cell P to thereby enable the control electrode S to ignite the glow relay tube.

The arrangement operates as follows. In non-ignited condition the voltage at the condenser C and thus between electrodes A and K is equal to the peak value of the alternating supply voltage. When the tube is ignited by the cell P, the voltage between A and K decreases to the operation voltage of the tube G. Assuming that the cause of said ignition is no more effective, an auxiliary D.C. current flows from the charged condenser C to the main electrodes A and K for an extended time, i.e. for several cycles of the supply voltage if the resistance and the capacity are sufficiently large. Whenever the supply voltage passes the positive half-cycle, an additional strong current will pass to the tube through the relay R to energize the relay circuit. Energization of the relay circuit will last while the storage circuit maintains a sustained discharge of the glow tube in the negative half-cycles of the supply voltage.

The glow tube will extinguish when the charge of the condenser through the main gap is exhausted sufficiently for the auxiliary current to be interrupted in a negative half-cycle. In this manner, the electro-mechanical relay was energized for a comparatively extended period and thereby could store the necessary energy, e.g. in the short circuit winding thereof, so that the relay remains energized for another predetermined time.

On extinction of the glow tube, the condenser is again charged towards the peak value of the supply voltage. If a further ignition impulse is received while the tube is extinguished and the relay is still energized, the process described is repeated and the relay stays energized. Accordingly, the relay is permanently energized as long as the control impulses occur within the prescribed intervals.

In order to illustrate the operation of the circuit shown, reference is made to the graph of Fig. 2 showing the currents and voltages in dependency of time. The A.C. voltage appearing at the supply terminals 1 and 2 is denoted with V_1 , while the D.C. voltage appearing at the capacitor C is denoted with V_2 . It is to be seen that first, that is when the glow relay tube has not yet ignited, the D.C. voltage V_2 is identical with the peak voltage of V_1 due to the operation of the rectifier G1. At the time of t_1 the glow relay is ignited, for example, by a light beam energizing the photocell P so that the cell can charge the capacitor Z. Since the voltage V_1 at this moment is in its negative half-wave, the current for the glow relay tube is supplied with the electric energy charged in the capacitor C so that a D.C. current J_2 is flowing to the main electrode A of the glow relay tube. In the next positive half-

wave of the A.C. voltage V_1 also a current J_1 is flowing to the electrode A and through the tube.

Due to the fact that the voltage appearing at the main electrodes of the tube A is not affected by the current flowing through the tube, the voltage V_2 is not influenced by the current J_1 so that also in the positive half-wave of the voltage V_1 the capacitor C continues to get discharged. The glow relay tube now remains ignited as long as the sum of J_1 and J_2 is larger than a critical current value J_{krit} which depends on the geometrical dimensions of the tube, the gas pressure, etc. In the graph of Fig. 2, J_1 and J_2 become smaller than J_{krit} at the time t_2 so that the glow relay tube extinguishes. However, the relay R remains energized. When a light beam falling into the photoelectric cell P continues to energize this cell, the capacitor Z is charged again and ignites the tube before the relay R is deenergized so that the operation as described is repeated. It is to be seen that the relay R remains energized as long as the light beam energizes the photocell P. It thus is possible to control the relay R by means of the small energy supplied by the cell P.

A particular advantage of this arrangement is that ignition of the arrangement can be obtained at any moment since a sufficiently positive direct voltage is present at electrode A owing to the storage circuit. It is therefore not necessary to synchronize the moment of ignition with the outer supply voltage.

It is important for some applications that the condenser and the voltage at electrode A rapidly return to the peak value of the alternating supply voltage after extinction of the tube. This is to ensure that a control impulse received immediately after extinction causes the main gap to be ignited with subsequent extinction delay independently of the momentary value of the supply voltage. This can be achieved by connecting a rectifier in parallel with the resistance W, which causes the condenser to be charged during the next positive half-cycle following extinction.

To explain this modification of the invention, reference is made to Fig. 3 showing a wiring diagram similar to that shown in Fig. 1. The corresponding circuit elements are denoted with the same reference symbols. Also the operation is identical so that only these elements will be described in which the diagram differs from that of Fig. 1.

In the embodiment of Fig. 3, the relay R is not provided with a short circuit winding but with a capacitor U and a resistor M being arranged as a serial connection in parallel to the mechanical relay R. The capacitor U and the resistor M also define a storage means for the relay so that the relay remains energized after the energizing current is switched off. Further, in parallel to the resistor M, there is arranged a rectifier Re, which serves the purpose to provide a quick recharging of the capacitor C when the glow relay tube was extinguished as outlined above.

It is evident that suitable dimensioning of the storage circuit will enable almost any extinction delay times to be obtained. By employing a relay having a short-circuited winding, the release delay can normally be extended to approximately 1 second. If a condenser connected in parallel is selected for retardation in place of a short-circuited winding (Fig. 3), the release retardation time may also be increased almost at will.

Further possibilities of solution with the method according to this invention may be found on the basis of the embodiment described. The problem involved is essentially to connect a suitable storage circuit to an electrode introduced into a tube, which electrode need not be identical with one of the main electrodes.

Various changes and modifications may be made without departing from the spirit and scope of the present invention and it is intended that such obvious changes and modifications be embraced by the annexed claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent, is:

1. A circuit comprising an alternating voltage source, a rectifier in series connection with said source to provide a pulsating D.C. voltage, the lowest momentary voltage thereof being below a predetermined value, an ignitable glow relay tube having two main electrodes and a control electrode, controllable by a small pulsating D.C. voltage when supplied thereto, said glow relay tube, when ignited by a second voltage supplied to said control electrode being conductive as long as a voltage above said predetermined value is applied to said main electrodes, a mechanical relay in series connection with the main electrodes of said glow relay tube, said two relays being connected to said first voltage source through said rectifier so that the glow relay tube will become conductive and said mechanical relay energized when said second voltage is supplied to said control electrode of said glow relay tube, storage means operatively connected with said mechanical relay to effect a continuous energizing of said mechanical relay for a first predetermined time after the glow relay tube has been extinguished due to a diminution of the voltage supplied to the electrodes thereof below said predetermined value, a series connection of a resistor and a capacitor arranged in parallel to said glow relay tube to provide a voltage above said predetermined value for a second predetermined time for said glow relay tube to maintain said glow relay tube conductive for said second predetermined time irrespective of the voltage applied to the control electrode thereof until the voltage of said capacitor has reached a value below said predetermined value, while said mechanical relay due to said storage means remains energized after said glow relay tube has been extinguished for said first predetermined time and only becomes deenergized when the supply of said D.C. voltage to said control electrode of said glow relay tube is interrupted for a period of time longer than said first predetermined time.

2. A circuit as claimed in claim 1, wherein said storage means have the form of a short circuit winding arranged on said mechanical relay.

3. A circuit as claimed in claim 1, said storage means having the form of a capacitor and a resistance in series connection arranged in parallel with said mechanical relay.

4. A circuit comprising alternating voltage source means, a rectifier in series connection with said alternat-

ing voltage source means for providing a pulsating D.C. voltage with the lowest momentary voltage thereof being below a predetermined value, an ignitable glow relay tube having two main electrodes and a control electrode, said tube being controllable by a small pulsating D.C. voltage when supplied thereto and when ignited being conductive as long as a voltage above said predetermined value is applied to said main electrodes, a mechanical relay in series connection with the main electrodes of said glow relay tube, said two relays being connected to said voltage source means so that the glow relay tube will become conductive and said mechanical relay energized when said pulsating D.C. voltage is supplied to said control electrode of said glow relay tube, storage means operatively connected with said mechanical relay to effect a continuous energizing of said mechanical relay for a first predetermined time after the glow relay tube has been extinguished, an impedance and a capacitor connected in series with each other and arranged in parallel to said glow relay tube to provide a voltage above said predetermined value for a second predetermined time for said glow relay tube to maintain said glow relay tube conductive for said second predetermined time irrespective of the value of said pulsating D.C. voltage applied to the control electrode thereof until said capacitor is discharged below said predetermined value, while said mechanical relay due to said storage means remains energized after said glow relay tube has been extinguished for said first predetermined time and only becomes deenergized when the supply of said pulsating D.C. voltage to said control electrode of said glow relay tube is interrupted for a period of time longer than said first predetermined time.

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