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CONTROL SYSTEM

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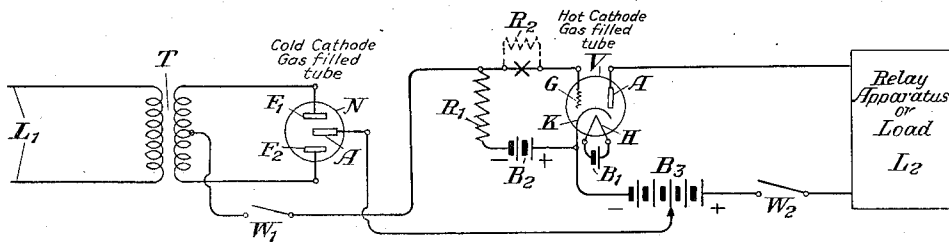


Fig. 1

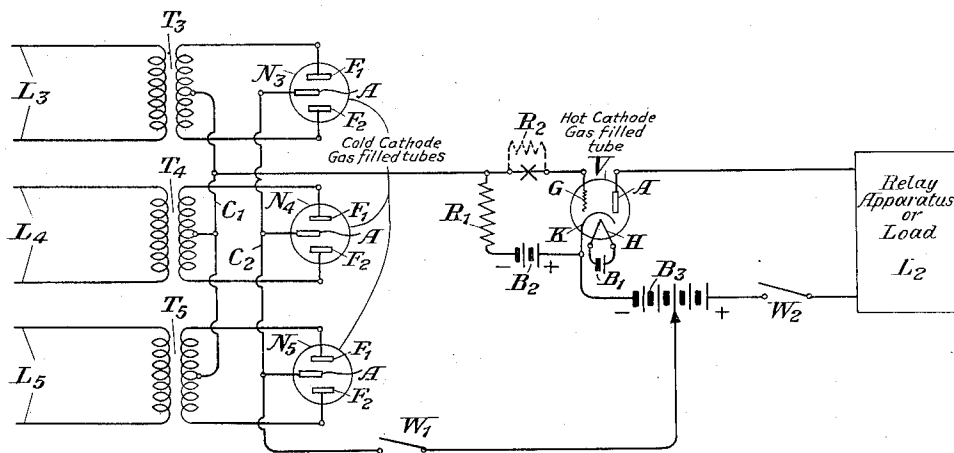


Fig. 2

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CONTROL SYSTEM

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7 Claims. (Cl. 250—27)

This invention relates to novel methods and apparatus for actuating relay systems or work circuits or the like. More particularly, this invention relates to arrangements for operating a relay system or work circuit or the like only when the voltage in an associated circuit equals or exceeds a predetermined value.

It has been discovered that a relay system or work circuit or the like may be operated and controlled by the flow of current through an associated circuit by interposing between the relay system or work circuit and the associated circuit a tube of any well known type which will act as a trigger device. When a cold cathode tube of the glow discharge type is employed for this purpose, the voltage present in the relay circuit or the work circuit may be greater than the voltage which will normally produce a glow discharge between the electrodes of the cold cathode tube and the tube will therefore be continually operated. Hence the associated circuit will be unable to control the relay system or work circuit as desired.

In order to overcome this condition it is proposed to connect between the relay system or work circuit and the associated control circuit a gas-filled tube of the hot cathode type in addition to a gas-filled cold cathode discharge tube of a gaseous type.

This invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing, in which Figure 1 shows one embodiment of this invention given merely for the purpose of illustration and Fig. 2 shows another embodiment of the invention having three associated control circuits, any one of which, when impressed with a voltage which is equal to or greater than some predetermined value, will cause the relay arrangement or work circuit to become operated.

Referring to Fig. 1 of the drawing, reference character L_1 designates an input circuit over which signals or other currents may flow. The circuit L_1 is connected to the primary winding of the transformer T , the secondary winding of which is connected to two of the electrodes, cathodes F_1 and F_2 , of the cold cathode gas-filled tube N which includes, in addition to the two cathodes F_1 and F_2 , a third electrode which is an anode designated A . The midpoint of the secondary winding of the transformer T is connected through a key or switch W_1 to the grid electrode G of a hot cathode gas-filled tube designated V . The switch W_1 may be of any form of open circuiting device. The tube V includes, in

addition to the grid G and anode A , cathode K and a heater H . The heater H is supplied with heating current from a battery or other source of potential designated B_1 . The grid G of the tube V is connected to the cathode K of that tube through a resistance R_1 and a battery B_2 , the positive terminal of which is connected to the cathode K of tube V and the negative terminal to the lower terminal of the resistance R_1 . The midpoint of the secondary winding of the transformer T is connected to the upper terminal of the resistance R_1 through the key or switch W_1 . A relay arrangement or work circuit or other form of load designated L_2 is connected between the anode A of the tube V and the cathode K of that tube through a battery or other direct current source of voltage designated B_3 . The negative terminal of the battery B_3 is connected to the cathode K of tube V while its positive terminal extends to the relay arrangement or load L_2 . The battery B_2 may consist of a plurality of cells connected in series as is the case in the ordinary storage battery, and the positive terminal of any one of these cells in the series may be connected to the anode A of the cold cathode gas-filled tube N . It will be obvious, however, that a potentiometer may if desired be bridged across the battery B_3 and that the movable arm of the potentiometer may be directly connected to the anode A of the tube N . It will be apparent also that the key or switch designated W_2 , which is interposed between the positive terminal of the battery B_3 and the relay arrangement or work circuit L_2 , may be employed to disconnect the circuit between these elements whenever desired.

Whenever an alternating potential is impressed upon the primary winding of the transformer T , as would be the case if an alternating potential were transmitted over the input circuit L_1 , a corresponding alternating potential will be impressed across the secondary winding of the transformer T , and the magnitude of this potential will depend on the ratio of the number of turns in the secondary winding to that in the primary winding. In the arrangement shown in the drawing the secondary winding will preferably have a greater number of turns than the primary and consequently the voltage across the secondary winding will be greater than that transmitted over line L_1 to the primary winding of the transformer T . Moreover, a discharge will occur between the cathodes F_1 and F_2 of the tube N when the voltage across the secondary winding of the transformer T is sufficient to break down the ionized gap between these cathodes. The gap

between the anode A of tube N and either of the cathodes F₁ or F₂ may be broken down when the voltage across the secondary winding of transformer T and the voltage of batteries B₂ and B₃ is greater than the break-down voltage between the anode and these cathodes. The gap between cathode F₁ and the anode A will be broken down during one-half of the cycle and the gap between the anode A and the cathode F₂ will be broken down during the other half of the cycle.

When any one of the gaps of the tube N becomes broken down, ionization of the gas contained within the tube will take place and the impedance within the tube between the anode and either of the cathodes will be reduced from an exceedingly high or infinite value to a comparatively low and predetermined value. By virtue of this reduction in the impedance within the tube N, a substantially large current will flow through the circuit which includes batteries B₂ and B₃, the anode A of tube N, and either or both of its cathodes F₁ and F₂, the secondary winding of the transformer T, the key W₁ and the resistance R₁. This current will cause a substantially large drop in potential across the resistance R₁.

The grid G of the tube V is normally biased to a substantially high negative voltage by the battery B₂. Because of this high biasing voltage only a very high voltage resulting from a drop across the resistance R₁ will produce a flow of current in the output circuit of the tube V. The resistance R₁ is of such magnitude with respect to the voltages of the batteries B₂ and B₃ and the internal voltage drop of the tube N that the voltage drop across the resistance R₁ will be sufficiently large and possibly greater than that required to overcome the normal bias of the grid electrode G of the tube V and thereby cause ionization of the gas within the tube V. This will bring about a large flow of current from the battery B₃ through the relay arrangement of work circuit L₂ which is interposed between the battery B₃ and the anode A of the tube V.

A large biasing potential, as is produced by battery B₂, is used in the grid circuit of the tube V so that only comparatively large voltages produced by the drop across the resistance R₁ will be sufficient to ionize the gas of the tube V and bring about the operation of the work circuit connected between the anode A and cathode K of the tube V. If a very small biasing voltage were employed in this grid circuit, a voltage of comparatively small magnitude might be sufficient to ionize the gas within the tube V and bring about the operation of the work circuit L₂ even when none of the discharge gaps of the tube N were broken down. The latter undesirable condition can arise from the great sensitivity of the tube V, and it must, therefore, be avoided. Thus, it will be seen that the use of the large negative bias of the grid circuit in the tube V as is used in the circuits of this invention renders the operation of the tube V more stable and free from false operation due to minor or transient effects.

In the arrangement shown in Fig. 1, the resistance R₁ is one of comparatively small magnitude. Inasmuch as this resistance couples the cold cathode gas-filled tube N to the hot cathode gas-filled tube V, the low magnitude of coupling resistance will increase the stability of operation of the circuits and render the circuits free from false operation due to minor or transient effects.

The arrangement shown in Fig. 1 of the drawing may be restored to its initial condition in several ways, as will now be shown. The keys W₁

and W₂ may be both opened, or the potential of the battery B₃ may be reduced sufficiently so that the effective potential applied to the anode A of the tube N will be less than the normal sustaining voltage of the tube N, thereby preventing any discharge between the cathodes and anode A of tube N from being sustained. It will be apparent also that the reduction in the voltage of the battery B₃ for restoring the circuit to its initial condition must also be sufficient to reduce the potential between the cathode K and the anode A of the tube V below the voltage required to sustain the glow between these elements of the tube.

A resistance R₂ shown in dotted lines may be inserted in series between the upper terminal of the resistance R₁ and the grid G of the tube V by opening the circuit of the conductor, as indicated by "X" in the drawing. This will permit a glow discharge to occur largely between the cathode K and anode A of the tube V. The resistance R₂, being of comparatively high magnitude, will prevent a sustained glow between the grid G and the cathode K or the anode A of the tube V after the opening of switches W₁ and W₂ to reset these tubes to their normal condition.

Fig. 2 of the drawing shows three input circuits L₃, L₄ and L₅ which may under ordinary conditions be independent of each other. The input circuit L₃ is connected to the cathodes F₁ and F₂ of tube N₃ through the transformer T₃, the circuit L₄ is connected to the cathodes F₁ and F₂ of the tube N₄ through the transformer T₄, and the circuit L₅ is connected to the cathodes F₁ and F₂ of the tube N₅ through the transformer T₅. Each of the tubes N₃, N₄ and N₅ is preferably a cold cathode glow discharge tube of the type shown in Fig. 1 and designated N therein, and each of these tubes includes, in addition to two cathodes, a third electrode which is an anode designated A.

The midpoints of the secondary windings of the transformers T₃, T₄ and T₅ are connected to each other through the common conductor C₁ and this conductor is connected to the upper terminal of the resistance R₁. The lower terminal of the resistance R₁ is connected to the negative terminal of the battery B₂. Moreover, the upper terminal of the resistance R₁ may be directly connected to the grid of the tube V or it may, if desired, be connected to the grid G through the resistance R₂ as shown also in Fig. 1 and described hereinabove. The anodes, each designated A, of the tubes N₃, N₄ and N₅, are connected together through a common conductor C₂ and this conductor extends to the movable contact associated with the battery B₃ through the key or switch W₁.

The presence of a substantial alternating current voltage in any one of the input circuits L₃, L₄ and L₅ will be transmitted through the corresponding transformer T₃, T₄ and T₅, respectively, and cause the gas in any one of the corresponding tubes N₃, N₄ and N₅ to become ionized so that the impedance between either of the cathodes of the ionized tube and the anode will be reduced from a very high or infinite value to a low and predetermined value. When the impedance between the anode and any one of the cathodes of the tubes N₃, N₄ or N₅ becomes so reduced, a voltage will be impressed across the resistance R₁ as described hereinabove in connection with Fig. 1 and the voltage across resistance R₁ will reduce the high negative bias of the battery B₂ impressed upon the grid G of the tube V, thereby causing a glow discharge to occur between the cathode K and the anode A of the tube V. When this oc-

curs, the battery B₃ will transmit a substantially large current to the relay apparatus or work circuit designated L₂. As in the case of Fig. 1, the circuits of Fig. 2 may be restored to their initial condition either by opening both of the keys W₁ and W₂ or by substantially reducing the voltage of the battery B₃ below the value required to sustain a glow discharge within tube V and any one of the parallel tubes N₃, N₄ and N₅ previously ionized.

When one of the input circuits such as L₃ receives a large alternating current potential which is, of course, transmitted through the transformer T₃ to the cathodes F₁ and F₂ of the tube N₃ and if this potential effect should break down the gap within that tube and produce a glow discharge therein, it is to be noted that no reaction will be produced in the input circuits L₄ and L₅ which are coupled to the tubes N₄ and N₅ connected in parallel with the tube N₃. Hence it follows that any one of the three circuits L₃, L₄ and L₅ may be used to trigger off the relay arrangement or work circuit designated L₂ through the tube V and through the tubes N₃, N₄ or N₅ associated with the input circuit receiving the high voltage, and while this occurs, no effect will be produced in the other input circuits which are not impressed with such high voltages. It will be apparent also that none of the voltage of batteries B₂ or B₃ will be transmitted back through any of the transformers T₃, T₄ and T₅ to the circuits which are not supplied with high voltage sufficient to break down the gaps of their associated tubes N₃, N₄ and N₅, respectively.

While this invention has been shown and described in certain particular arrangements merely for the purpose of illustration, it will be understood that this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. The combination of a first gas-filled tube having two cathodes and an anode, a second gas-filled tube having a heater, a cathode, a grid and an anode, the cathodes of the first tube being connected to each other and to the grid of the second tube, a battery connected between the anode of the second tube and its cathode, a point intermediate to the terminals of the latter battery being connected to the anode of the first tube, a resistance, and a biasing battery connected in series with said resistance between the grid and cathode electrodes of the second tube.

2. The combination of an input circuit, a transformer, the primary winding of said transformer being connected to said input circuit, a first gas-filled tube having two cathodes and an anode, the secondary winding of said transformer being connected between the cathodes of said first tube, a second gas-filled tube having a heater, a cathode, a grid and an anode, the midpoint of the secondary winding of said transformer being connected to the grid electrode of the second tube, a first battery, an output circuit connected in series with said first battery between the cathode and the anode of said second tube, a point intermediate to the terminals

of the first battery being connected to the anode of the first tube, a resistance, and a second battery connected in series with said resistance between the grid and cathode of the second tube for biasing the grid to a high negative potential with respect to said cathode.

3. The combination of a first gas-filled tube having a cathode and an anode, the breakdown voltage of which is a small predetermined value, a second gas-filled tube having a cathode, a grid and an anode, the breakdown voltage between the cathode and anode of which is a large, predetermined value, a source of potential of a value which equals or exceeds said large predetermined value which is connected between the cathode and anode of the second tube, the anode of the first tube being connected to a point intermediate to the terminals of the source of potential, a resistance, and a second source of potential which is connected between the grid and cathode of the second tube through said resistance.

4. The combination of a control circuit, a circuit to be controlled, means for operating the circuit to be controlled only when the voltage in the control circuit exceeds a predetermined value, said means comprising a cold cathode gas-filled tube having an anode and two cathodes, a hot cathode gas-filled tube, and aperiodic means for interconnecting said tubes between the control circuit and the circuit to be controlled so that the discharge gaps of both tubes may be simultaneously broken when the total alternating voltage in the control circuit exceeds the predetermined value.

5. Control apparatus comprising a cold cathode gas-filled tube having an anode and two cathodes, a hot cathode gas-filled tube connected in tandem with the cold cathode tube, means of aperiodic character for simultaneously breaking down the discharge gaps of both tubes when an alternating voltage exceeding a predetermined value reaches the cold cathode tube, and means for preventing the discharge gap of the hot cathode tube from being broken down except when the discharge gap of the cold cathode tube has broken down.

6. The combination of a plurality of cold cathode gas-filled tubes connected in parallel with each other, each of said cold cathode tubes having an anode and two cathodes, a hot cathode gas-filled tube, and means for breaking down the discharge gap of the hot cathode tube when the discharge gap of any one of the cold cathode tubes has broken down.

7. The combination of a plurality of parallel circuits which are mutually non-reactive, a cold cathode gas-filled tube connected to each of said circuits, each cold cathode tube having an anode and two cathodes and being discharged when the total alternating voltage in the associated circuit exceeds a predetermined value, a hot cathode gas-filled tube coupled to all of the cold cathode tubes, and means for discharging the hot cathode tube when any one of the cold cathode tubes has become discharged.

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