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H. B. DEAL

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GAS TUBE RELAY CIRCUIT

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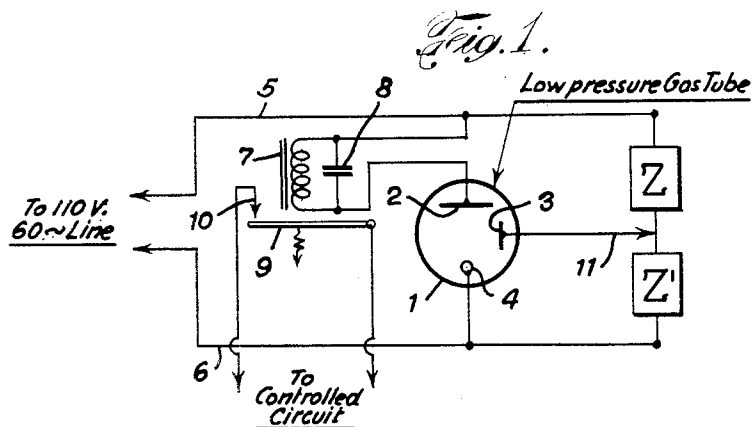


Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

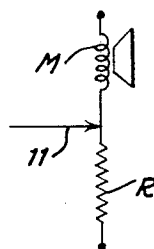
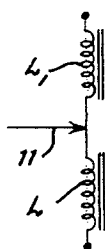
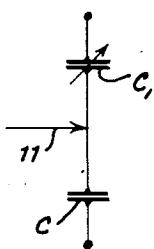
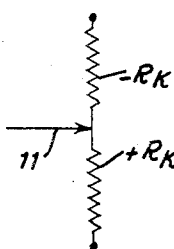
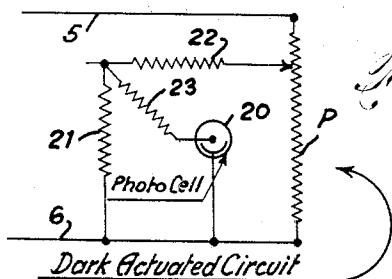
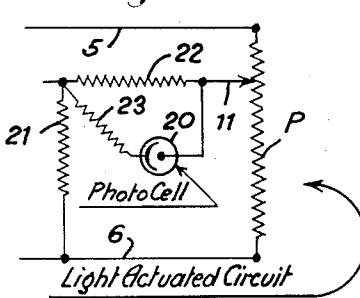
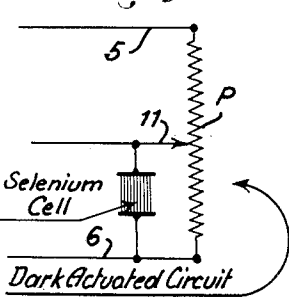
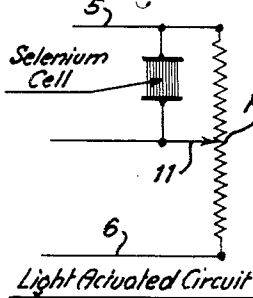


Fig. 6.

Fig. 6a.

Fig. 7.



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GAS TUBE RELAY CIRCUITS

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3 Claims. (Cl. 315-157)

My present invention relates to gas tube relay circuits, and more particularly to relay control circuits utilizing a low pressure gas tube of the cold cathode type.

One of the main objects of my present invention is to improve generally the simplicity and reliability of relay control circuits, and more especially to provide a relay control circuit employing a gas triode whose discharge is dependent upon the division of voltage across a potential divider connected between the plate and cold cathode of the triode and across the source of energizing voltage.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims; the invention itself, however, as to both its organization and method of operation will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically several circuit organizations whereby my invention may be carried into effect.

In the drawing:

Fig. 1 shows a circuit embodying my invention, the voltage divider being generically represented,

Figs. 2 to 5 inclusive illustrate respectively different modifications of the potential divider,

Figs. 6 and 6a show two further types of potential dividers,

Figs. 7 and 7a illustrate two additional forms of potential dividers.

Referring now to the accompanying drawing, wherein like reference characters in the different figures designate similar circuit elements, the tube 1 is generally an ionic-cathode, glow-discharge tube. It contains a plate, or anode, 2, a grid, or starter anode, 3 and a cold cathode 4. The tube, as shown, is a gas triode of the OA4-G type. The electrodes are sealed in a bulb filled with an inert gas or vapor at reduced pressure. The invention is not restricted to this type of cold cathode relay tube. Indeed, any cold cathode gas tube may be utilized, so long as the plate is enabled to carry current upon discharge occurring in the tube in response to the control electrode 3 assuming a "striking" potential.

The energizing voltage source, shown by way of illustration as of 110 volts and 60 cycles, feeds lines 5 and 6. The cathode 4 is connected to one side of the energizing system, say line 6. The line 5 is connected to plate 2 through the winding of electromagnet relay 7. Condenser 8, across the relay winding, acts as a smoothing condenser. It helps to hold the relay armature in the actuated,

or closed, position without chattering. The armature of the relay is denoted by numeral 9, and is normally spring-biased out of contact with the switch contact 10. Hence, closure of switch 8-10 completes any desired type of controlled circuit. Thus, the controlled circuit may include a lamp, bell, alarm or indicator; or it may be any control device which is to be actuated upon energization of relay 7 to close switch 10-9. For example, a motor to start a heating system may be controlled.

The control circuit comprises a potential divider Z-Z' connected between the lines 5 and 6. The control electrode 3 is connected by lead 11, preferably terminating in an adjustable tap, to any desired point along the divider Z-Z'. The latter, from a generic viewpoint, consists of a pair of impedances adapted to develop thereacross a potential difference. The nature of the impedances, the magnitude thereof, and the positioning of tap 11 will determine the "striking" point of the gas tube. In normal operation of the tube 1, a relatively small amount of electrical energy supplied to the control electrode, or starter-anode, 3 initiates a glow discharge between cathode 4 and electrode 3. This discharge produces positive ions which assist in initiating the main discharge between cathode and plate 2. The plate current, flowing during the cathode to plate discharge, energizes the winding of relay 7 thereby to close switch 10-9.

The tap 11, regardless of the nature of the divider impedances, is adjusted to a point such that the starter-anode 3 is maintained at a potential just below that required for break-down. Since the "striking" potential of the tube 1 is obtained from the division of line voltage at the divider Z-Z', any control that will change the division of the voltage will "strike" the discharge between cathode and electrode 3. This will, in turn, release the discharge to the plate 2 which carries a heavy current supplied by the power line. Hence, the switch 10-9 will be closed to complete the controlled circuit. The particular virtue of this invention is the negligible (or for a capacity divider, zero) power consumption in the stand-by, or non-actuated, condition. Filament types of gas or "hard" vacuum tubes have been used, but they all require continuous power consumption to the amount of several watts. If the divider resistance is of the order of 1,000,000 ohms the power consumption is of the order of milliwatts. Divider resistances of many times this value are feasible, so that the power consumption may be in the order of microwatts.

The divider Z—Z' may take various forms. As shown in Fig. 2, they may be a pair of temperature control resistors. The resistors $-R_k$ and $+R_k$ represent resistors having opposite temperature coefficients. A change of temperature will cause a change in voltage division thereby triggering the gas triode. In Fig. 2 the resistors can be chosen to have merely different coefficients, rather than opposite. The controlled circuit could include a device to indicate the temperature change affecting the divider. The controlled circuit could, also, be a device to effect a control which restores the temperature.

In Fig. 3 the divider consists of series condensers C—C₁. The tap 11 is adjusted between the condensers. The upper capacity C₁ could be, for example, a liquid level device whose capacity depends on the height of a body of liquid. It is then arranged that as long as C and C₁ have a definite magnitude relation, the voltages thereacross will be such as to maintain the electrode 3 just below the "striking" potential. Upon condenser C₁ undergoing a change in capacity to change the voltage division the tube 1 will have a discharge to the plate 2. In Fig. 4 it is shown that capacities C—C₁ may be replaced by inductors L—L₁ respectively. Of course, either section of the divider may be the variable section.

In Fig. 5 the divider consists of a resistor R in series with the output element M of a sound pick-up device, such as a microphone. For example, in sound detection work the output element M is arranged to cooperate with resistor R to prevent discharge of tube 1 in the absence of sound. A predetermined change in voltage division across R—M results in setting of an alarm device in the controlled circuit.

In Fig. 6 there is shown a potential divider P of resistor form; a selenium cell is connected between the line 5 and tap 11. As is well known, the selenium cell is a device whose resistance varies with light falling thereon. In the position shown, the balance of P (after proper adjustment for balance by tap 11) prevents ignition of the gas tube for the then-prevailing illumination of the cell. Any increase of light intensity at the cell in effect raises the 60 cycle voltage difference between the starter-anode and cathode thereby causing discharge to the plate 2.

Similarly, and as shown in Fig. 6a, for another setting of tap 11 and the positioning of the selenium cell between tap 11 and line 6, a voltage just below that on the control electrode which will initiate a discharge is found, under the then-prevailing illumination of the cell. In this case any decrease of illumination on the selenium cell will initiate a gas tube discharge thereby closing the relay switch 10—9.

In Fig. 7 there is shown a circuit wherein a photocell 20 replaces the selenium cell of Fig. 6. The photocell may be of the gas or hard vacuum types. The divider P has its slidable tap 11 arranged in series with a resistor 22 of about 25 megohms. The resistor 22 has shunting it the photocell in series with a resistor 23. The resistor 21, of about 20 megohms, connects the electrode end of resistor 22 to line 6. In Fig. 7a the photocell is connected across the resistor 21. The latter is the "dark-actuated" position of the photocell, as in the case of the selenium cell in Fig. 6a. The potentiometer P is adjusted by tap 11 to its critical setting such that an increase in illumination of cell 20 initiates discharge in the tube 1 in the case of Fig. 7, whereas a decrease in illumination causes the tube 1 to discharge in the case of Fig. 7a. Diminished sensitivity can be had

by less critical settings of potentiometer P. In the case of both Figs. 6 and 7 the controlled circuit may include lighting systems or the like. It will be seen that in the arrangements of Figs. 6 and 7 the relay control circuit is light-responsive.

In each of Figs. 7 and 7a the photocell resistance is in parallel with an element of the resistance divider. If the photocell resistance changes, due to a change in illumination upon it, the resistance divider ratio is upset, and the trigger anode can then ignite the current-carrying discharge. The extra resistances in Figs. 7 and 7a represent an actual working instrument. The ranges of resistance variation in the photocell are very high between light and dark. The additional series and shunt resistances hold these variations within limits so that impractically large divider variations are not required.

Once a gas tube is ignited, there must be a reduction of voltage to a value below the gas extinction de-ionizing voltage to shut it off preparatory to the next ignition cycle. For alternating current this extinction is attained twice each alternation when the line voltage is momentarily zero. For direct current (or battery) operation, this may be done manually, or with a circuit interrupter or by other automatic means, as for example a blocking (motor boating) network associated with the gas tube.

While I have indicated and described several systems for carrying my invention into effect, it will be apparent to one skilled in the art that my invention is by no means limited to the particular organizations shown and described, but that many modifications may be made without departing from the scope of my invention, as set forth in the appended claims.

What I claim is:

1. In combination with a source of alternating current energizing voltage, a potential divider consisting of pure resistance thereacross, a gas discharge tube including a cold cathode, a plate and a starter-anode, a controlled circuit including control means arranged in circuit with the plate, means connecting the cathode to plate path of the tube across said source whereby extinction of the gas tube ignition is attained twice each alternation when the alternating source is momentarily zero, and means free of impedance connecting said starter-anode to a predetermined point of said divider such that said starter-anode is just below the "striking" voltage of said tube and said divider having such a relatively high resistance magnitude that the power consumption of the gas tube in non-ignited state is negligible.

2. In combination, in a relay control circuit, a controlled circuit including as an element thereof a switch device, a relay for controlling said switch, a gas tube provided with at least a cold cathode, a plate and a control electrode, a pair of alternating current energizing lines at a potential difference of predetermined value, means connecting the cathode to plate path of the tube in series with the relay between said lines whereby the gas tube ignition is extinguished twice each alternation when the alternating source is momentarily zero, a potential divider consisting of pure resistance connected between said lines, means free of impedance connecting said control electrode to a point on the divider such as to prevent discharge between cathode and plate, and said divider having a section thereof whose resistance is subject to variation such as to change the voltage division across the divider and said divider having a resistance magnitude of the order of one

million ohms thereby to reduce the power consumption of the tube in non-ignited state to a negligible value.

3. In combination with a source of alternating current energizing current, a potential divider comprising pure resistance thereacross, a gas discharge tube including a cold cathode, a plate and a starter-anode, a controlled circuit including a control switch arranged to be actuated from the plate current, means connecting the cathode to plate path of the tube across said source whereby extinction of the gas tube ignition is attained

twice each alternation when the alternating source is momentarily zero, and means substantially free of impedance connecting said starter-anode to a predetermined point of said divider such that said starter-anode is just below the "striking" voltage of said tube, and said divider having a resistance magnitude of at least one million ohms thereby permitting said tube to consume negligible power from said source in the "open" condition of the control switch.

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