

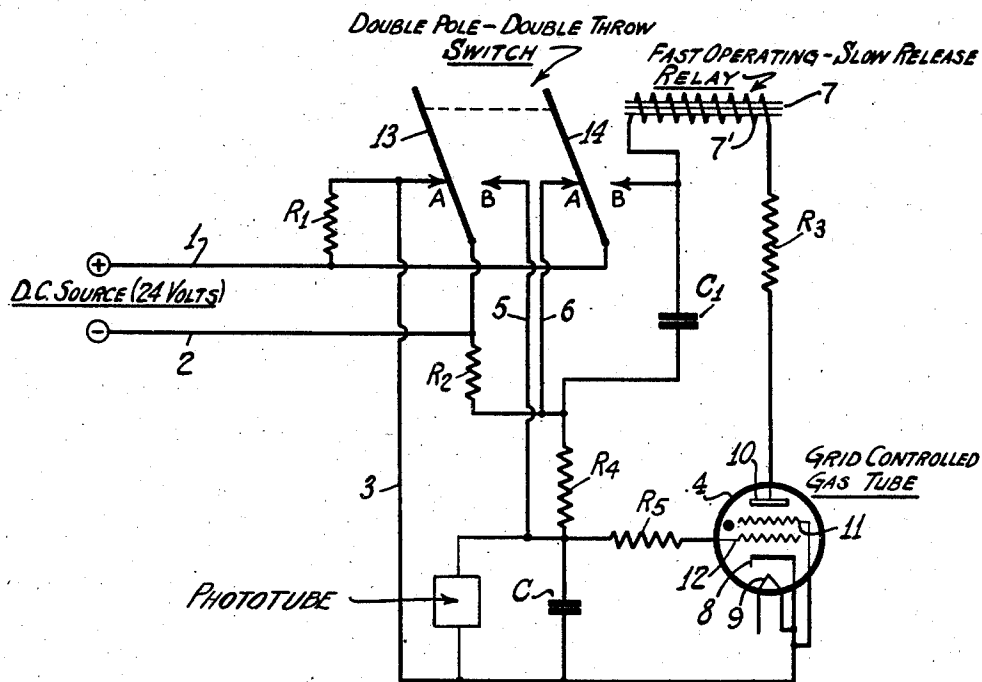
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VOLTAGE DOUBLER AND TIMER CIRCUIT

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VOLTAGE DOUBLER AND TIMER CIRCUIT

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1 Claim. (Cl. 315-226)

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My present invention relates to a combined direct current voltage doubler and timer circuit, and more particularly to a circuit of the latter type employing a grid-controlled gas tube.

There are many instances wherein timer circuits employing gas tubes are required to be operated from a battery line. For example, assume a 24 volt battery line is the only source of energizing current available for a timer circuit utilizing a gas tube which requires a plate voltage well over 25 volts for reliable operation. It will be seen that there is presented a problem which is usually not encountered in energization from an alternating current source. It is possible, of course, to step up the direct current voltage from the battery line, but such stepup requires additional devices and increases the cost of the equipment.

Accordingly, it may be stated that it is one of the main objects of my present invention to provide a method of doubling the direct current voltage from a battery line in order to operate a grid-controlled gas tube at a plate voltage well above 25 volts for use in a timer circuit.

Another important object of this invention is to provide a combined direct current voltage doubling and timing circuit which employs a grid-controlled gas tube, and which circuit utilizes a fast operating-slow releasing relay with double pole-double throw contacts capable of operating with accuracy at the time and speeds required, and having low voltage and current operating values.

Another important object of my invention is to provide a means for providing reliable operation of an electronic switching means of a timing device at direct current supply voltages lower than that at which reliable operation can be normally assured.

Another important object of this invention is to provide a method of providing increased ionizing potential on a gaseous tube, used in a switching or timing circuit, thereby to assure more reliable operation of the tube; a voltage doubling effect being produced from a direct current supply to energize an electrode of the gas tube during the normal operation of the tube.

Still other objects of the invention are to improve generally the efficiency and reliability of timing circuits utilizing gas tubes and adapted to be energized from a battery line, and more particularly to provide such circuits in an economical manner.

Other features will best be understood by reference to the following description taken in connection with the drawing in which I have indicated diagrammatically one circuit organization whereby my invention may be carried into effect.

Referring now to the accompanying drawing, I have shown the positive and negative terminals of a direct current source, and by way of example

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let it be assumed that the source has a +24 volt potential difference between the positive and negative points of the battery line to which circuit connections are to be made. The numeral 4 designates a gas tube, and specifically the latter may be a thyratron of the 2050 type. This type of tube is provided with an electron emission electrode 8 which is adapted to be heated by heater element 9. The plate 10 has interposed between it and cathode 8 a shield grid 11 and the control grid 12. The heater element 9 may be heated with a current of approximately 6.3 volts. The circuit connections to element 9 are omitted. The grid 11 is tied back to the cathode lead 3 which connects cathode 8 to a contact A of switch 13.

The black dot within the tube envelope designates that the tube has a gas filling. The plate 10 is connected through a resistor R₃ to one end of the winding 7' of the electromagnet 7. The opposite end of the winding 7' is connected to a contact B of the second switch 14. The contact B of switch 14 is connected to the cathode lead 3 through a series path comprising condenser C₁, resistor R₄ and condenser C. The junction of resistor R₄ and condenser C is connected through resistor R₅ to the control grid 12 of tube 4.

The contact B of switch 13 is connected by lead 5 to the junction of resistor R₄ and condenser C, while the contact A of switch 14 is connected by lead 6 to the upper end of resistor R₄. The adjustable arm of switch 14 is connected by lead 1 to the positive potential point of the direct current energizing source, as is contact A of switch 13. The contact A is connected to the lead 1 through a resistor R₁. The negative terminal lead 2 is connected to the adjustable arm of switch 13, as well as to the upper end of resistor R₂.

The dotted line between the adjustable switch arms 13 and 14 indicates that the switches are thrown concurrently from their respective contacts A to the respective contacts B. In other words, switches 13 and 14 and their associated A and B contacts provide a double pole-double throw switch. The electro-magnet 7 functions to control the position of switches 13 and 14. Those skilled in the art are fully acquainted with the manner of constructing such a switch mechanism. It is only necessary to point out for the purposes of this disclosure that magnet 7, when energized by current flow through winding 7', quickly attracts the adjustable arms 13 and 14 into the respective B positions, while when the electro-magnet is de-energized there is a slow release of the switch arms toward their respective A contact positions. The relay is, therefore, of the fast operating-slow release type, and is well known. The double pole-double throw switch 13-14 is capable of operating with accuracy at the timing

speeds required, and has low voltage and current operating values. To maintain accuracy and stability in the circuit, it is advantageous that the insulation between the relay contacts be good, and that any arcing be thoroughly squelched. Condenser, or condenser-resistor combinations, across the relay contacts may be found useful in squelching any arcing which may occur, and in maintaining reliable operation.

The type 2050 gas tube normally requires a plate voltage well over 25 volts for reliable operation, and this voltage is provided by the novel method of doubling the voltage from the direct current source to which connections 1 and 2 are made. The operation of the gas tube will first be explained. The tube 4 operates similarly to a switch, or relay, except that very little power is taken to operate it. For a certain combination of positive plate voltage and negative grid voltage the plate-to-cathode circuit becomes conducting. In other words, the tube will fire. For voltage values less positive on the anode, or more negative on the grid, the tube will not be caused to conduct. Once the plate-to-cathode circuit does become conducting, however, the grid voltage has essentially no effect on operation of the tube, and the plate voltage must be reduced below the tube drop itself, usually around 8 to 10 volts, in order to extinguish the tube. In this circuit, the grid 12 never becomes positive.

When the switches 13 and 14 are adjusted to their B positions the condenser C₁ is charged through switch 14—B and resistance R₂ to a positive potential equal to the line voltage. The timing condenser C is charged to a negative potential through switch 13—B and resistance R₁. That is, the upper terminal of condenser C is connected through lead 5 and switch section 13—B to the negative lead 2, while the lower terminal of condenser C is connected through lead 3 and resistor R₁ to the positive lead 1. The values of the resistances of R₁ and R₂ are adjusted to allow full charging of these condensers within the time that the switches 13 and 14 are in their B positions. The larger this time can be made, the higher the magnitudes which can be assigned to resistances R₁ and R₂. Therefore, the less dissipation will be required in these resistances. If desired, either of resistances R₁ and R₂ may act as an electrical load, or work, circuit.

When the switches 13 and 14 are in their respective A positions, due to de-energization of the electromagnet 7, the battery voltage will be in series with the potential on the condenser C₁, and, therefore, will effectively double the line voltage applied to the plate 10 of tube 4. Condenser C will now be connected to the positive potential point of the battery line through the resistor R₄, and will, therefore, tend to charge to a positive potential. This occurs by virtue of the fact that the upper terminal of condenser C is connected through resistor R₄, lead 6, switch section 14—A to lead 1, while the lower terminal of the condenser C is connected to the negative lead 2 through a path consisting of lead 3 and switch section 13—A. This latter feature allows the accuracy of timing to be increased, since the control grid 12 of the tube 4 will reach its firing potential while condenser C is discharging on the steeper portion of this characteristic. Accordingly, normal changes in charging voltage or firing potential will alter the timing only slightly. Variation of the timing is obtained by adjusting the values of the resistor R₄ and condenser C. The resistor

R₅ in series with grid 12 is utilized to assure that the grid current will not exceed its maximum rating.

In this circuit, the double pole-double throw switch is first adjusted to make the contacts B, which charges C₁ positive and C negative. The tube is non-conducting. Then, the switch is allowed to make contacts A, which increases the positive potential of the plate and condenser C loses its charge accordingly to the time delay caused by the values of resistor R₄ and condenser C. Instantaneously on the making of contacts A the tube is nonconducting, and only after a definite period of time elapses, during which the condenser C has discharged from a highly negative value to a low value, will the tube be allowed to fire (become conducting), even under its increased anode potential. Once the tube fires, the relay pulls up the switch arms 13 and 14 to respective contacts B which breaks the anode circuit, and causes the tube to become non-conducting. However, due to the slow-releasing feature of the relay the switch arms 13 and 14 remain on respective contacts B long enough to charge condensers C₁ and C as explained before when the arms drop back to contacts A, and the cycle is repeated automatically from then on.

Phototubes may be connected into the circuit at various desired points. For example, a phototube could be connected across condenser C to control the frequency of timing, if desirable. Such a phototube is schematically represented in the drawing. The resistor R₃ is adjusted in conjunction with the inductance of relay winding 7' to maintain the peak current through the gas tube below 500 milliamperes, and within a safe value of current for the relay. The following specific values are given merely by way of example: C₂=1 microfarad; R₄=1 megohm; R₅=10,000 ohms.

While I have indicated and described a system 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 organization shown and described, but that many modifications may be made without departing from the scope of my invention.

What I claim is:

In combination with a source of direct current of relatively low voltage value, a pair of condensers, a double-pole double-throw switch, said switch in a first position thereof separately connecting said condensers to said source to charge them, a thyatron tube provided with at least an electron emitter, a control grid and plate, means connecting one of the charged condensers between the control grid and emitter in a manner to charge the control grid negative relative to the emitter, means connecting the second charged condenser in a circuit for applying a positive voltage to said plate, said last circuit including said switch in the second position thereof which connects said current source and second charged condenser in additive relation whereby a positive voltage is applied to the plate which is substantially higher than said low voltage value, said switch in its said second position connecting said first charged condenser to said direct current source in a sense to reduce the negative charge on the control grid, and means in circuit with said plate for automatically actuating said switch to said first position in response to firing of said thyatron tube thereby to recharge said two condensers.