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TIME MEASURING SYSTEM

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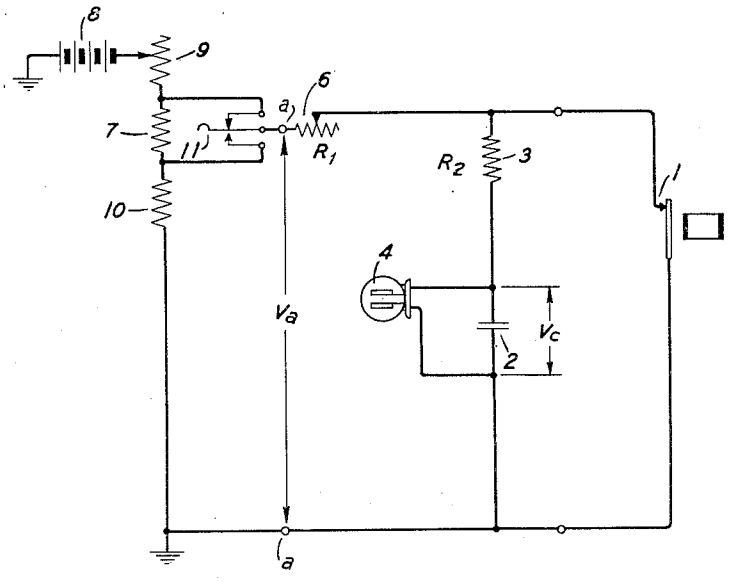

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TIME MEASURING SYSTEM

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5 Claims. (Cl. 175—183)

This invention relates to improvements in time measuring systems and more particularly to the utilization in such systems of gaseous conductor or discharge tubes for the purpose of providing a simple and effective means for determining the passage of a predetermined interval of time.

The gaseous conductor or discharge tubes utilized in the arrangements of this invention are tubes filled with a low pressure gaseous content which, for purposes of illustration, might be neon, argon, helium, mercury vapor or combinations of gases of this group. Such tubes have the characteristic of breaking down and becoming conductive on one voltage and remaining in such a conductive state on a much lower voltage. It is one of the primary features of this invention therefore, to utilize a discharge tube of the above type in combination with a condenser and resistance so that the breakdown potential on the tube may be controlled through the potential on the condenser, the charging time of which is made equal to the time interval to be measured. If the time interval elapses before the breakdown potential of the tube is reached, the condenser is short-circuited or otherwise prevented from attaining a higher voltage by the interval-producing means and the tube prevented from flashing. On the other hand if the time interval is longer than the time taken to charge the condenser to the breakdown potential of the tube said tube is caused to flash, the visible luminosity of which furnishes the signal that the time interval is longer than its predetermined value.

Another feature of the invention relates to an arrangement whereby the resistance in series with the condenser is calibrated in terms of the time taken to break down the tube so that once the resistance is calibrated in terms of this time interval for any known voltage supply and tube break down potential, it remains fixed thereafter for all other voltage changes and tube break down variations and compensations therefor will be made over a separate variable resistance that controls the potential across the condenser and across the tube.

The time-measuring circuit itself is based on the following two phenomena: (1) The potential across a condenser being charged in series with a resistance element is a function of the time the voltage is applied to the series combination of the ohmic resistance of said resistance element and of the capacity of the condenser; (2) Tubes of the character described have a definite breakdown voltage at which point the tube emits light.

In these circuits the charging of the condenser is started at the beginning of the time interval to be measured. If the charging voltage on the condenser reaches the breakdown voltage of the tube before the charging of said condenser is stopped by the contacts that produce the time interval to be measured, a momentary glow in the tube will be noted. If the resistance is now varied until the glow is just prevented from occurring it will be known that the resistance is of such a value as to allow the condenser to reach a potential practically equal to the breakdown voltage of the tube. Since the voltage which the condenser attains is constant and a function of the time and the resistance (other things remaining equal), the resistance in series with the condenser may be thus calibrated in units of time.

A clearer conception of the scope and purpose of the invention may be obtained from the following description taken in connection with the attached drawing and appended claims. In the drawing, 1 represents the contacts whose open period is to be measured, 2 the timing condenser, 3 a resistance in series with said condenser, 4 the neon or similar lamp, 6 the time calibrated resistance, 7 and 10 the elements of a potentiometer, 8 a battery, 9 a variable resistance, and 11 a switching key.

As said before, my invention makes use of the well known electrical principle that in a circuit that involves a capacity C in series with two ohmic resistances R_1 and R_2 in a closed circuit with a source of battery E, then the voltage V_a across the terminal of the circuit a—a, as shown, and the voltage V_c across the plates of the condenser 2 are governed by the relation

$$(1) \qquad V_c = V_a\left(1-\epsilon^{\frac{-t}{RC}}\right)$$

where $R=R_1+R_2$ and t=time taken to raise the voltage across the plates of the condenser to the value V_c.

The gas-filled glow lamp 4 is shunted across the plates of the condenser so that the voltage across the condenser is impressed upon the elements of the lamp.

When the breakdown voltage of the lamp is reached the lamp will glow while the condenser is discharging. If the open periods of contact 1 are constant and recurrent, R_1 (resistance 6) can be varied until the lamp just fails to glow on account of the short-circuiting of the condenser 2 by contact 1. Under such conditions the voltage

reached by the condenser will be practically equal to the breakdown voltage V_b of the lamp. That is,

$$V_b = V_a\left(1-\epsilon^{\frac{-t}{RC}}\right) \quad (2)$$

Rearranging this equation we have

$$\epsilon^{\frac{-t}{RC}} = 1-\frac{V_b}{V_a} \quad (3)$$

or,

$$\epsilon^{\frac{t}{RC}} = \frac{1}{1-\frac{V_b}{V_a}} \quad (4)$$

and

$$\frac{t}{RC}\log \epsilon\epsilon = \log \epsilon^{\frac{1}{1-\frac{V_b}{V_a}}} \quad (5)$$

and

$$t = RC \log \epsilon^{\frac{1}{1-\frac{V_b}{V}}} \quad (6)$$

From the last Equation 6 it may be seen that if C and

$$\frac{V_b}{V_a}$$

are kept constant, the time t will vary directly with the resistance R and R may be calibrated in units of time. In the circuit shown in the diagram, since resistance 3 is fixed, only resistance 6 would be varied and calibrated in terms of time units.

The constant ratio between voltage V_b and V_a is attained by varying the voltage across the potentiometer by means of variable resistance 9. To measure a time with this circuit key 11 is operated, contact 1 is opened and resistance 9 is varied until the lamp glows. The potentiometer is then delivering a voltage V_b across the terminals of the circuit a—a, as measured by the fixed resistance 10 of said potentiometer. Key 11 is now released and resistance 6 (R_1) is now adjusted, while contact 1 is delivering the open period to be measured until lamp 4 glows. When this happens, the value of resistance 6 indicates the time interval. The reason for this is in the fact that resistance 7 of the fixed potentiometer has a fixed ratio to resistance 10 of said potentiometer. Then, assuming the voltage to vary linearly with the total resistance of the potentiometer, the ratio of the total voltage supplied through both resistances of the potentiometer, that is, resistances 7 and 10, is a constant multiplied by the value of the voltage supplied only through resistance 10. That is,

$$V_a = KV_b, \text{ or } \frac{V_b}{V_a} = 1/K \quad (7)$$

Then, according to Equation (6), the value of R (i. e. resistance 6) will measure the time interval, and may be calibrated as such from Formula 1.

In the circuit above described, it is assumed that the potentiometer resistance is low compared to R_1. Otherwise the time indicated will vary with the voltage used. If it is desired to have the time vary with the voltage, this can be accomplished since R_1 can be made large if C is made small.

The above arrangements and methods for compensating the voltage and tube variations by a resistance which controls the potential across the condenser and across the tube can be applied to any circuit arrangement for measuring the time interval of the operation of any two contacts, such as for instance, the break interval as in the illustration, or the make interval, or the interval between the break of one set of contacts and the make of another, or between two sets of makes or two sets of breaks, etc.

What is claimed is:

1. The method of measuring a time interval which consists in applying a potential across the plates of a condenser during the time interval to be measured, discharging said condenser through a glow lamp when said condenser reaches a potential equal to the breakdown potential of said lamp and adjusting the charging rate of said condenser until said lamp just fails to glow upon the expiration of the time interval whereby the degree of adjustment becomes a measure of the time interval.

2. In a device for measuring a time interval, a condenser, a source of potential, a circuit for charging said condenser from said source, means for rendering said charging circuit effective during the time interval to be measured, a glow lamp in shunt of said condenser through which said condenser discharges when said condenser becomes charged to the breakdown potential of said lamp, and a variable resistance for adjusting the charging rate of said condenser until said lamp just fails to glow upon the expiration of the time interval whereby said resistance becomes a measure of the time interval.

3. In a device for measuring a time interval, a condenser, a source of potential, a circuit for charging said condenser from said source, means for rendering said charging circuit effective at the start of the time interval and for rendering said circuit ineffective at the end of said interval, a glow lamp in shunt of said condenser through which said condenser discharges when said condenser becomes charged to the breakdown potential of said lamp, and a variable resistance for adjusting the charging rate of said condenser until said lamp just fails to glow at the end of said time interval whereby said resistance becomes a measure of the time interval.

4. In a device for measuring a time interval, a condenser, a source of potential, a circuit for charging said condenser from said source, means responsive to the start of said time interval for rendering said charging circuit effective, means responsive to the end of the time interval for rendering said charging circuit ineffective, a glow lamp in shunt of said condenser through which said condenser discharges when said condenser becomes charged to the breakdown potential of said lamp, and a variable resistance for adjusting the charging rate of said condenser until said lamp just fails to glow at the end of said time interval whereby said resistance becomes a measure of the time interval.

5. A device for measuring the duration of an electrical energy impulse comprising a measuring circuit including a glow discharge tube which emits light upon the application of a given voltage thereto, a condenser, adjustable means to impress upon said condenser a voltage derived from the impulse which during the impulse period charges the condenser for attainment of its maximum potential at the end of the impulse period and to impress said potential upon said glow tube, means to adjust said derived voltage to a value which will cause said potential when at maximum to be substantially equal to the emission voltage of said tube, and means to determine the ratio of said derived voltage and said potential.

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