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RATIO CIRCUIT

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Fig. 1.

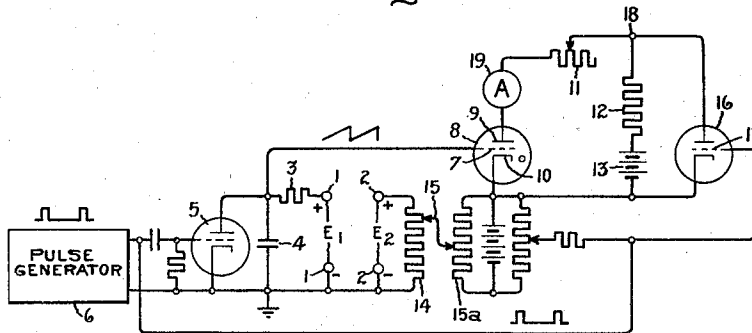
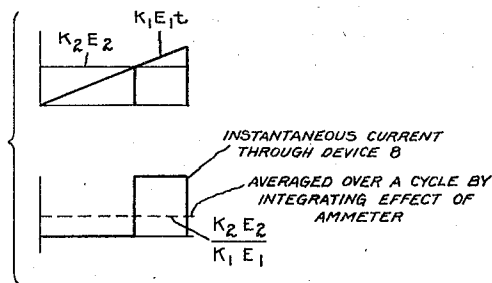


Fig. 2.



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UNITED STATES PATENT OFFICE

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RATIO CIRCUIT

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6 Claims. (Cl. 171—95)

The present invention relates to circuits for measuring the ratio of two voltages.

An object of my invention is to provide an improved ratio circuit which will handle rapidly varying voltages.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 is a circuit diagram and Fig. 2 is a diagram explaining the operation.

Referring to the drawing there is shown a ratio circuit having terminals 1, 2 to which are applied the voltages E_1 , E_2 whose ratio is to be determined. The terminals E_1 are connected across a saw-tooth circuit comprising a resistance 3 and a condenser 4, the condenser being shunted by a discharge device 5 keyed by a pulse generator 6 to short circuit the condenser at intervals determined by the keying pulse repetition rate. The condenser and resistance are related to the repetition rate so that the voltage across the condenser starts from zero at the end of each keying pulse and increases linearly to a maximum immediately preceding the succeeding keying pulse, thus converting the voltage E_1 to a saw-tooth voltage having a magnitude equal to $k_1 E_1 t$. The saw-tooth voltage is applied to the control grid 7 of a gaseous discharge device 8 having an anode 9 and a cathode 10 connected in series with resistances 11, 12 and a source of constant voltage 13. The voltage E_2 is connected across a voltage divider 14 having a tap 15 applying a fraction $k_2 E_2$ of this voltage to the cathode 10. A potentiometer 15a between the tap 15 and the cathode adjusts the cathode potential to a value such that when both voltages E_1 and E_2 are zero, the device 8 is on the verge of firing. When E_1 and E_2 have some positive value, the net change in bias on the device is equal to the instantaneous difference of the saw-tooth voltage applied to the grid ($k_1 E_1 t$) and the voltage applied to the cathode ($k_2 E_2$). Since the device 8 is normally non-conducting, it is obvious that, by proper choice of the constants k_1 and k_2 , for some values of time less than the interval between keying pulses, $k_1 E_1 t$ will be slightly greater than $k_2 E_2$ and the device 8 will fire due to the net positive change in bias. The time of firing, as apparent from Fig. 2, will be a measure of the ratio of the voltages E_1 and E_2 . Once the device 8 has fired, the

current through the device is constant and is not subject to control by the grid bias until the current has been reduced below the ionization value. This is accomplished by a device 16 connected across the resistance 12 and the voltage supply 13 and having a control grid 17 connected to the keying pulse generator. The device 16 is normally biased off and is biased on during each keying pulse, reducing the voltage at terminal 18 below the ionization value. The device 8 accordingly conducts only during that part of the interval between keying pulses during which $k_2 E_2$ is equal to or less than $k_1 E_1 t$. Since the device 8 when conducting conducts at constant current, an ammeter reading the average current through the device will indicate the ratio of $k_2 E_2 / k_1 E_1 t$ up to the point at which $k_2 E_2$ is greater than $k_1 E_1 t$. From this point on, there is an ambiguity since $k_2 E_2$ is never less than $k_1 E_1 t$ and the device 8 is always biased off. This ambiguity can be avoided by interchanging the voltages, i. e., by connecting E_2 to terminals 1 and E_1 to terminals 2. The lower diagram of Fig. 2 shows the instantaneous current through device 8 by the solid line block and the average of this block over a cycle by the dashed line. Due to the mass of the meter movement, an ammeter will, by its inherent integrating properties, give a reading proportional to the dashed line.

In the use of the ratio circuit, (1) with both E_1 and E_2 disconnected, the potentiometer 15a is adjusted to a value such that the device 8 is on the verge of firing; (2) with a known value of E_1 connected to terminals 1, and E_2 disconnected, the resistance 11 is adjusted to cause full scale deflection of the ammeter 19; and (3) with a known value of E_2 connected to terminals 2, the tap 15 is adjusted to give an ammeter reading corresponding to the known value of E_2 / E_1 . The circuit is now adjusted for use with any voltages. The ratio E_2 / E_1 , expressed in percentage, given by the formula (100% minus the percentage ammeter deflection) will be ambiguous for the case where the ammeter deflection is zero percent which corresponds to all ratios of E_2 / E_1 greater than unity. This ambiguity can be removed by interchanging the voltages to obtain (instead of the ratio E_2 / E_1) the ratio E_1 / E_2 .

While I have shown particular embodiments of my invention, it will be understood that many modifications may be made without departing from the spirit thereof, and I contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A ratio circuit for measuring the ratio of two voltages comprising, a bias controlled device, means for converting one of the voltages to be compared to a voltage varying linearly with time and directly with the magnitude of the voltage, means for biasing said device in accordance with the instantaneous difference of said time varying voltage and the other voltage to be compared in such a manner that the time said device conducts depends upon the magnitude of said instantaneous difference, and means for utilizing the time said device conducts to determine the ratio of said two voltages.

2. A ratio circuit for measuring the ratio of two voltages comprising, a grid controlled gaseous discharge device normally biased off, a constant voltage supply circuit for the device, means for converting one of the voltages to be compared to a voltage varying linearly with time and directly with the magnitude of the voltage, means for biasing said device on in accordance with the instantaneous difference of said time varying voltage and the other voltage to be compared whereby the average current through the device is a measure of the ratio of said two voltages, and means in said circuit for indicating said ratio.

3. A ratio circuit for measuring the ratio of two voltages comprising, means for converting one of said voltages to a saw-tooth voltage vary-

ing linearly with time and directly with magnitude, and means for utilizing the time when the converted voltage and said second voltage have a predetermined relative value as a measure of the ratio of said two voltages.

4. A ratio circuit for measuring the ratio of two voltages comprising, means for converting one of said voltages to a saw-tooth voltage varying linearly with time and directly with magnitude, and means responsive to the difference of said converted voltage and said second voltage for indicating the ratio of said two voltages.

5. A ratio circuit for measuring the ratio of two voltages comprising, means for converting one of said voltages to a saw-tooth voltage varying linearly with time and directly with magnitude, and means responsive to the time when said converted voltage and said second voltage have a predetermined relative value for indicating the ratio of said two voltages.

6. A ratio circuit for measuring the ratio of two voltages comprising, means for converting one of said voltages to a voltage varying in magnitude in accordance with time and with the magnitude of said one voltage whereby the relation of said converted voltage to said other voltage varies with time, and means responsive to the time of occurrence of a predetermined relation of said converted voltage to said other voltage for determining the ratio of said voltages.

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