June 2, 1931. H. RÜHLEMANN 1,807,708

PROCESS OF AND MEANS FOR TIMING ELECTRIC FUSES

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Fig.1.

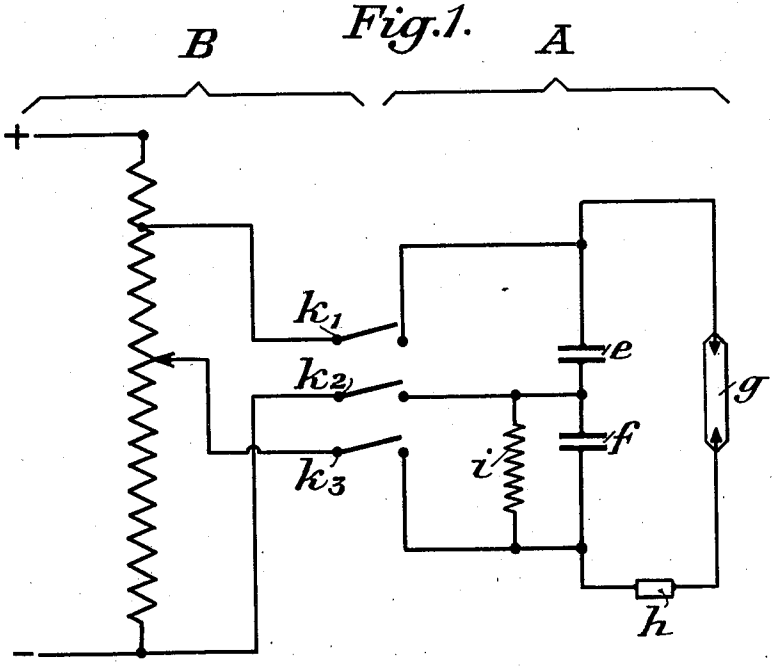

Fig.2.

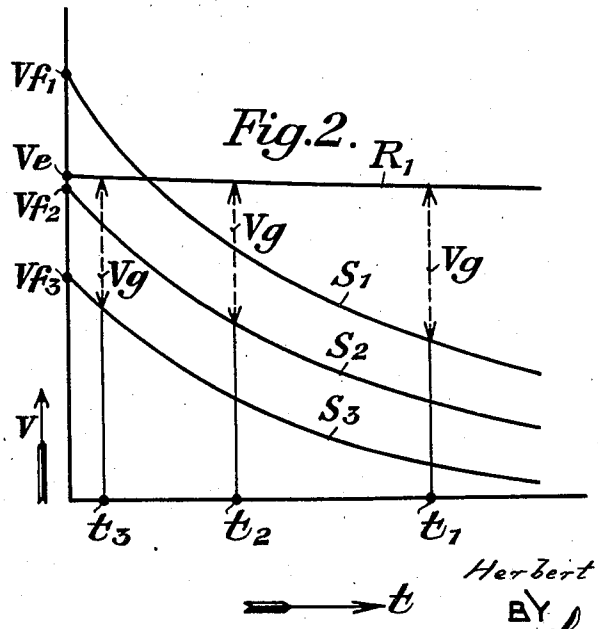

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Fig.3.

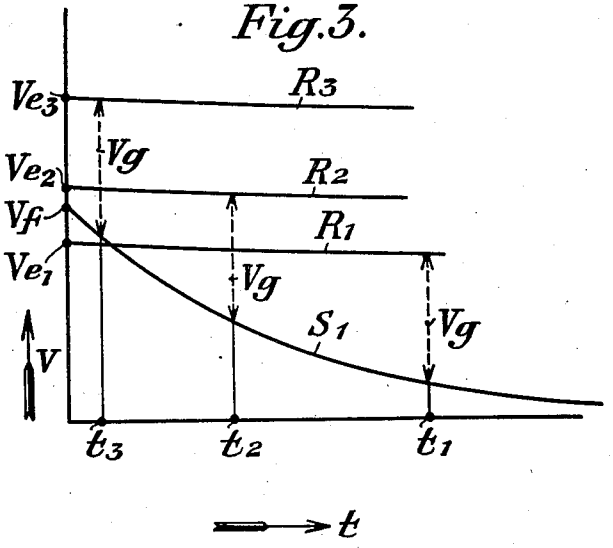
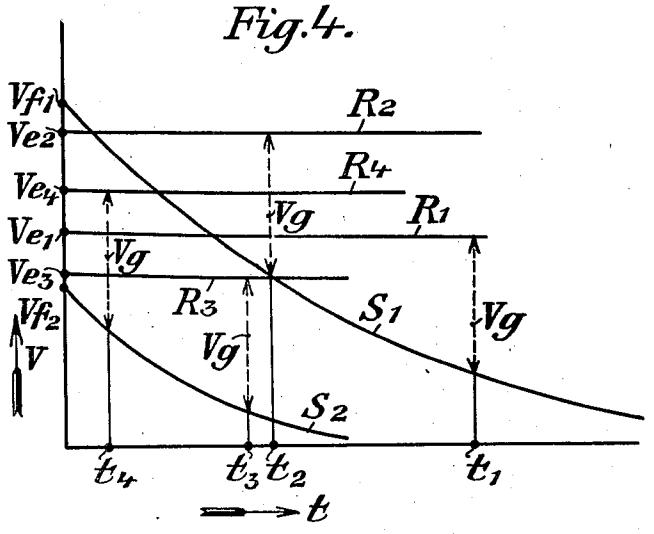


Fig.4.



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UNITED STATES PATENT OFFICE

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PROCESS OF AND MEANS FOR TIMING ELECTRIC FUSES

Application filed December 16, 1929, Serial No. 414,499, and in Germany June 14, 1929.

This invention relates to a process of and means for timing electric fuses having two oppositely connected condensers to furnish the ignition current.

It has already been proposed to vary the time of ignition of fuses of this type by varying the charging potential difference applied to the condensers, i. e., by using a different adjustment of the charging potential for each different time period desired.

The present invention accomplishes the same result by varying the charging potentials of the two condensers relatively to each other.

In accordance with this feature, the invention provides, in electrical time igniting devices, which comprise two condensers connected in opposition and provided with means for mutual variation of the voltage of their charging energy, for adjusting the different times of ignition by varying the charging voltage of the two condensers relatively to one another. For this purpose there is added to the above mentioned time ignition device having two condensers connected in opposition, a source of electric current, said current source being capable of simultaneously delivering two different voltages which are variable with respect to one another and of feeding a respective one of said voltages to each of the condensers respectively to charge the same.

In contradistinction to such prior methods, according to which both the condensers of such a fuse are indeed charged to different voltages to secure the different time periods, but always uniformly in each case, i. e., both being charged to the same potential, the new process and device present the advantages that all the required time periods can be provided for with a relatively low potential difference. For example, where the old process required for a very accurate ignition time period in the fuse for shells of about one second firing period, a charging potential difference of about 1000 volts, a maximum of only about 200 volts is sufficient with my invention, and this not only simplifies the battery or other source of current but also the structure and the insulation of the condensers in general.

To adapt the new process in practice, the charging apparatus for the two condensers is arranged to furnish two potential differences simultaneously, one at least of which is adjustable.

The new time ignition device and the methods of timing attainable thereby are described hereinafter in connection with the drawings.

Figure 1 of the drawings shows the diagram of connections of an electrical time ignitor together with the source of current belonging thereto; and

Figs. 2 to 4 are diagrams showing curves between potential and time, i. e., the relation between the discharges of the two condensers for different time periods; in Fig. 2, the charging potential of the condenser which is shunted by a resistance is varied; in Fig. 3, the charging potential of the other condenser is varied; and in Fig. 4, the charging potentials of both condensers are varied simultaneously.

In the diagram, Fig. 1, A is the fuse and B the charging apparatus. The two condensers e and f are connected in opposition to each other through a spark gap g, such as a tube containing a rare gas which allows the current to flow only at a potential of a predetermined minimum value, and an ignition medium h. The condenser f is also shunted by a constant high resistance.

The charging apparatus B is provided with three terminals k_1, k_2 and k_3 and furnishes a constant potential between k_1 and k_2; the potential between k_2 and k_3 is variable, relatively to the constant potential of k_1 and k_2, within such maximum and minimum limits that the difference of potential between k_1 and k_2, and between k_2 and k_3, always lies below the potential difference necessary to break down the spark gap g.

The constant potential difference between k_1 and k_2 serves to charge one of the ignition condensers e, while the variable potential difference between k_2 and k_3 is applied to the condenser f, which is shunted by the resistance i. In the time-potential diagram of Fig. 2, the line R_1 represents the discharge of the condenser e after it is charged to the constant potential V_e and after the disconnection

of the condenser terminals from the source of current. The curves S_1, S_2 and S_3 show the discharge rates of the second condenser f under the conditions produced by the varying charging potentials V_{f1}, V_{f2} and V_{f3}. The diagram shows that the potential, necessary to break down the spark gap g (potential V_g) and, therefore, to ignite the substance h, builds up between the condensers e and f after varying periods of time, t_1, t_2 and t_3, and does so the more rapidly in proportion as the variable charging potential for condenser f is lower relatively to the constant potential for the other condenser e.

Instead of varying the charging potential for condenser f, which is shunted through resistance i, that for the other condenser e may be varied by a suitable arrangement of the connections between the charging apparatus and the fuse; the time-potential diagram of Fig. 3 represents these conditions.

In order to obtain a long time point t_1, one of the condensers, as f, is charged by the potential V_f, and the other condenser e with the potential V_{e1}. For shorter time periods t_2 or t_3, the potential of condenser e is increased to V_{e2} or V_{e3}.

The diagram shows that, in order to obtain very short time periods, the condenser e must be charged with a potential, which is approximately equal to the sum of the charging potential V_f of the second condenser f plus the ignition potential V_g. This is, however, the highest potential to which the insulation of the fuse is subjected. The discharge curve S_1, beginning at potential V_f, of the condenser f is flatter in the course of a discharge, since the rate of discharge of the condenser constantly diminishes, and it follows that the accuracy of the adjustments for large time periods becomes lower.

The combined adjusting method, represented by way of example in the diagram of Fig. 4, obviates this disadvantage, by varying the charging potential of both condensers. The charging apparatus B, Fig. 1, is then arranged to furnish a variable potential both between the terminals k_2 and k_3 and between the terminals k_1 and k_2. The condenser f, Fig. 1, which discharges through the resistance i, is charged for a certain interval for short time periods with a potential V_{f2} and for the remaining time periods with the potential V_{f1}. This higher potential V_{f1} then furnishes a sufficiently rapid discharge for the longer time periods, so that a satisfactory accuracy of the actual ignition time period is obtained. The further adjustment within this restricted time period is then obtained by varying the charging potential of the second condenser e, so that the time period t_4 is obtained with potential V_{e4} and time period t_3 with potential V_{e3}. For the longer time periods t_1 or t_2, the condenser f, shunted by the resistance i, is first charged with the greater potential V_{f1} and then the further adjustment is obtained by varying the second charging potential, so that the time period t_2 results from potential V_{e2} and time period t_1 from potential V_{e1}.

I claim as my invention:—

1. An electrical time ignition device comprising an electrical igniting means, a spark gap, two condensers, a circuit connecting said condensers in opposition to one another, and also including, in series therewith, the igniting means and the spark gap, a high resistance shunted across the terminals of one of said condensers, and a source of electricity capable of simultaneously delivering two different voltages, variable with respect to one another, and connections whereby said voltages may be temporarily applied to the respective condensers to charge the same.

2. A method of adjusting the time of ignition of electric fuses which consists in charging two condensers to different voltages dependent upon the ignition time desired, maintaining one of the condensers at substantially its full charging voltage, partially discharging the other condenser at a rate determined by a constant resistance across its terminals, opposing the voltages of the two condensers to one another, and applying the progressively increasing difference of the said voltages to produce a discharge through a gap having a definite minimum break down voltage and through the fuse, in series with one another, causing said discharge to ignite the electric fuse at a definite time.

In testimony whereof, I affix my signature.

HERBERT RÜHLEMANN.