Feb. 10, 1931. H. RÜHLEMANN 1,791,606

SETTING ELECTRIC PROJECTILE FUSES

Filed April 16, 1928

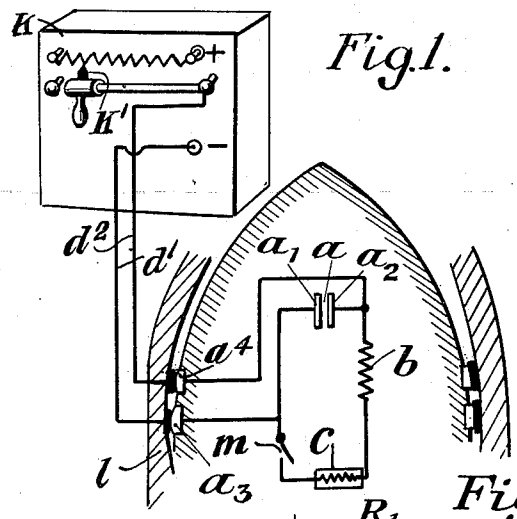

Fig.1.

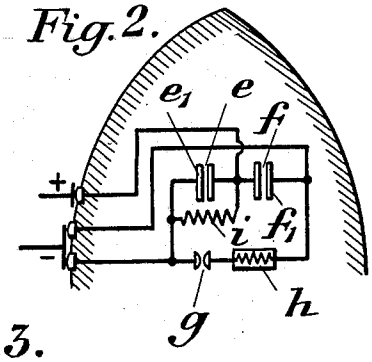

Fig.2.

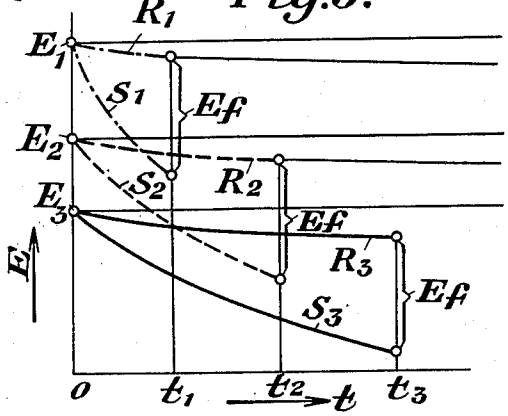

Fig.3.

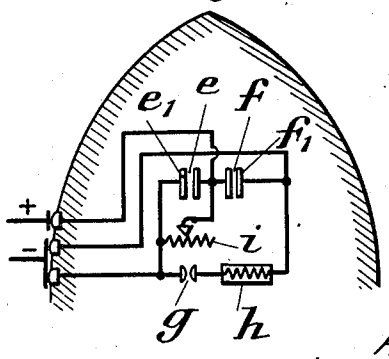

Fig.4.

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UNITED STATES PATENT OFFICE

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SETTING ELECTRIC PROJECTILE FUSES

Application filed April 16, 1928, Serial No. 270,465, and in Germany April 28, 1927.

My invention relates to a method of setting electric projectile time fuses, in which the discharge of electric condensers is used to ignite the composition.

It has already been proposed to set electric fuses of this type by varying the conditions of the discharging current of the condenser, which is loaded up always to equal voltage, to which end an adjustable high ohmic resistance is arranged in the discharging circuit, that includes the igniting means, of the condenser, so that according to the adjusted resistance amount the condenser is discharged more quickly or slowly through the igniting means, whereby an earlier or later ignition moment is obtained.

According to my invention, the setting of different ignition moments is obtained by varying the loading conditions of the condenser, that means, by differently measuring the loading voltage supplied to the condenser. By increasing this voltage a more rapid discharge of the condenser and therewith an earlier ignition moment is obtained, while a reduction of the loading voltage results in a slower discharge and therewith a later ignition moment.

To carry out this new method, a voltage transformer is inserted in the circuit, that feeds the condenser of the fuse and is connected to a source of current, which in a known manner is either arranged in the projectile or separately therefrom. Furthermore, if a generator is used as source of current, according to the invention the generator itself is enabled to produce different voltages, by applying thereto regulating devices of known design. So, e. g. when the source of current, united with the projectile, consists of a permanent magnet shiftably arranged in an induction coil, either the relative speed of the shift of the magnet in the coil is made adjustable by means of a brake, or the number of windings of the induction coil is made adjustable, whereby in both cases the voltage of the current generated is varied.

In combination with the measure of loading up the condenser of the fuse from a source of current that is separate from the projectile, the setting method of my invention is of a particular advantage to obtain a very simple construction of the fuse and a very simple manner of setting it. In spite of this the fuse itself comprises only a condenser and a high ohmic resistance or a combination of several condensers as power accumulator, and the igniting means, that may consist simply of a spark or bridge ignitor, while no adjustable setting mechanisms need to be provided on the fuse itself or on the projectile. The setting of the ignition moments is effected on the fuse loading apparatus which is separate from the projectile by suitably tuning the loading voltage, while the setting of the fuses takes place automatically in and by loading their condensers. Furthermore, when the contacts of the loading apparatus are arranged on the gun itself, that means either in the gun barrel or closure, so that the loading and therewith the setting of the fuse takes place after the introduction of the projectile in the gun barrel shortly before or immediately in firing the projectile by actuating the firing mechanism, the setting to equal bursting moments of a series of projectiles to be fired successively does not require any special time-consuming measure. The firing speed of the gun is thus considerably increased and a re-setting of the fuses to a new ignition moment can be performed in a simple manner, even when the projectile is already in firing position in the gun barrel.

In order to allow of my new method to be more easily understood, the wiring diagrams of different embodiments of fuses serving to carry out my setting method are illustrated in Figures 1, 2 and 4 of the drawing, that accompanies and forms part of this specification, while Figure 3 shows the time-voltage curves of the condensers of a fuse designed according to Figure 2, with different loading voltages.

In all the embodiments illustrated the fuses are loaded from a source of current, as shown in Fig. 1 by K having a variable resistance K_1 which is separate from the projectile and is adapted to deliver a voltage of an amount to be adjusted at will within two limits.

The fuse illustrated in Figure 1 is fitted with a condenser *a* serving as electric power

accumulator, the two armatures a_1 and a_2 of which are interconnected through a high ohmic resistance b and an igniting means c. The latter is formed by an incandescent bridge igniter having a heating wire embedded in an igniting composition, the latter being heated by the wire up to ignition temperature when the current is flowing therethrough. On the outer surface of the projectile shell are provided two contact pieces a_3 and a_4 which are insulated from the projectile wall and may be connected to the poles d_1 and d_2, in a receptacle 1, of a source of current K. The contact pieces a_3 and a_4 suitably extended annularly round the shell and are conductively connected to the two armatures a_1 and a_2 of the condenser. The switch m closes when the projectile is fired so that the current from the condenser will flow through the igniting means c.

According to whether the condenser a has been loaded with a current of higher or lower voltage, a current of higher or lower strength flows through the igniting means c and its heating wire is heated up to the igniting temperature after a shorter or longer lapse of time. The high ohmic resistance b serves in principle to extend the discharge of the condenser on a certain period of time. As this resistance is constant, according to Joule's law the heat produced in the time unit in the heating wire of the igniting means is proportional to the square of the loading voltage introduced in the condenser a.

In the embodiment illustrated in Figure 1 a current begins to flow from condenser a through the igniting means c at once after loading the condenser a and disconnecting its contact pieces a_3 and a_4 from the wires d_1 and d_2 leading to the source of current. Therefore, the projectile must be fired constrainedly in dependence on the loading of the condenser, and the loading itself must thus be effected in the gun barrel shortly before or when the projectile is fired.

In order to load the fuse by means of a special apparatus arranged at a distance from the gun, according to an arrangement not shown a contact device is inserted in the discharging circuit of the condenser a, which contact device is normally open and is designed as to be closed automatically by the action of inertia only when the projectile is fired.

With the hereinbefore described fuse according to Figure 1 merely an incandescent wire bridge igniter can be used. Besides, due to the capacity of the condenser being not high, very distant ignition moments cannot be obtained, as in these cases the radiation of heat from the composition has a too great noxious influence, so that the temperature of the heating wire does not reach at all the degree required for the ignition.

These drawbacks are obviated by the fuse designed according to the wiring diagram illustrated in Figure 2. This fuse contains two condensers e and f which are loaded up to equal voltage. The similar poles e_1 and f_1 of these two condensers are interconnected through a spark gap g and an igniting means h formed by a spark or wire bridge igniter. A high ohmic resistance i is further connected in parallel to the condenser e.

The spark gap g inserted in the circuit possesses a practically infinite resistance as to currents of a voltage lower than its sparking voltage, that means, only with a voltage of such as amount, that the gap is bridged under spark formation, a current flows through the spark gap and therewith through the igniting means. Instead of the spark gap g another electric time lag relay of similar action may be connected in series with the igniting means, so e. g. a glowing zone the electrodes of which are lodged in vacuo or in a gas-filled space.

After loading the condensers e and f and disconnecting their contact pieces from the poles of the source of current, the one condenser e discharges through the resistance i. A voltage grows thereby between the armatures e_1 and f_1 of the two condensers, which voltage after having reached a determined amount produces a spark over gap g. By the current flow thereby provoked through the igniting means h the composition of the latter is ignited, whereby further the ignition of the bursting charge of the projectile is effected in known manner. The spark gap g inserted before the igniting means h serves so to say as an automatic switch, which is bridged only upon an exactly determined voltage arising between the armatures e_1 and f_1 of the two condensers and, by previously acting as electric relay, it prevents any flow of current through the igniting means h and a discharge of the condenser f. When the igniting means h is formed by a spark igniter, that possesses a practically infinite resistance below the igniting voltage, the spark gap g may be dispensed with.

According to the higher or lower voltage the condensers e and f are loaded up to, the one condenser e discharges through the constant resistance i more quickly or more slowly and the voltage required to form the spark at g and to provoke a current flow through the igniting means h grows up between the armatures e_1 and f_1 in a shorter or longer lapse of time. These discharge phenomena are illustrated by the voltage-time curves of Figure 3 with different loading voltages. R_1, R_2 and R_3 denote the voltage-time curves of the one condenser f (own discharge), while S_1, S_2 and S_3 denote those of the second condenser e (discharge through resistance i) for the loading voltages E_1, E_2 and E_3, respectively. With the highest voltage E_1 of the spark gap g the sparking voltage E_1 required

between the two condensers is reached after the time t_1, with the lower loading voltage E_2 after the longer time t_2 and so on. With a low loading voltage the discharge of the one condenser *e* through the high ohmic resistance *i* does not take place so quickly. Hence, by raising the loading voltage, earlier ignition moments and by lowering the voltage later ones can be set and obtained. The ignition of the composition takes place immediately at the instant the current starts flowing through the igniting means *h*, the instant a spark springs over at the gap *g*.

In the embodiment illustrated in Figure 4, the wiring diagram of which corresponds to that shown in Figure 2, the high ohmic resistance *i*, through which condenser *e* discharges, is designed as a regulating resistance.

This resistance *i* can at first be made adjustable only within narrow limits and serves in this condition to adjust the fuse in manufacturing it. Thereupon, when the fuse is tested after assemblage, the resistance *i* is so set, that, with a determined loading voltage the sparking voltage of the spark gap *g* is reached after an exactly determined lapse of time. This measure allows of certain inaccuracies that happen to arise in the manufacture, of the condensers, the spark gap etc. to be compensated for. Variations of the igniting means are of no influence on the ignition moment, when the described connection is employed.

However, the resistance *i* can be made adjustable also within wider limits. In this case it is of advantage to lodge it in a rotatable ring like the composition rings used in time fuses.

In combination with a source of current that is capable to deliver a current of a voltage adjustable at will, an igniting device is thus obtained, which allows of different igniting moments to be set either by the mere different determination of the loading voltage for the condensers, or merely by determined variation of the discharge time of the one condenser *e*, or by simultaneously varying both the said loading voltage for the condensers *e* and *f* and the discharge time of condenser *e*.

What I claim, is:—

An electric time fuse system comprising an electric igniting means; at least one condenser adapted to store the ignition current; and an external source of current having means to give up currents of different strengths for charging said condenser.

In testimony whereof I have affixed my signature.

HERBERT RÜHLEMANN.